REQ. NO. 2-9094-1

CONTRACT REPORT NO. OSQ82-00142

PROPOSAL FOR

DESIGN & INSTALLATION OF

PULVERIZED COAL BURNERS AND

SORBENT INJECTION SYSTEM

FOR

CFB GAGETOWN, N.B.

DSS NO. 15SQ.23440-2-9094-1

FOSTER WHEELER NO.2-51-2793

JAN 20 19[illegible]
MICROMEDIA

72 pp
2 drawings

TABLE OF CONTENTS

SECTION		PAGE
1.0	THE COAL BURNERS	
	1.1 Burner Design	1
	1.2 Low NO_x Burner Background	4
	1.3 Burner Installation	10
	1.4 Burner Operation for Emission Control	11
2.0	BURNER MANAGEMENT SYSTEM: - EVALUATION AND RECOMMENDATION	14
3.0	SORBENT INJECTION	17
	3.1 Limestone Handling System	18
	3.2 Location of the Injection Point	23
	3.3 EPA Test Results	27
	3.4 Choice of Sorbent	32
4.0	CONSTRUCTION SEQUENCE	35
	4.1 Burner and Limestone Injection System Installation	35
5.0	COSTS	36A - 36E
6.0	QUESTIONS AND ANSWERS - COMMENTS ON DRAFT REPORT MARCH 23, 1983	36F - 36L
APPENDIX A	- Burner Management System Equipment List	37
	- Burner Management System Operating Features	
	- Ignitors	
APPENDIX B	- Bibliography	42
APPENDIX C	- Terms and Conditions of Sale	45

EXECUTIVE SUMMARY

Foster Wheeler Ltd. (FWL) is pleased to present this report and proposal to install modern low NO_x burners and a sorbent handling system for in-situ capturing of sulfur dioxide. Extensive work has been done in these areas by sub-contractor Foster Wheeler Energy Corp. (FWEC) which has considerable experience in the design of internally staged low NO_x burners as well as in-situ sulfur capture. An internally staged low NO_x burner is one which achieves low NO_x levels with all the combustion air flow entering the furnace through the throat. FWEC's Controlled Flow/Split-Flame burner is a second generation internally staged burner which has been in utility field service since 1979. It is easily retrofitable, generally requiring no structural or pressure part modifications for either industrial or utility steam generators.

In contrast, externally staged burners (those requiring tertiary air ports), necessitate major structural and pressure part modifications and control system additions. Consequently, FWL and FWEC do not offer such externally staged low NO_x systems.

Installation of the Controlled Flow/Split-flame burner at Gagetown only requires a change of throat refractory and some additional bracketry to support the new registers. The coal nozzle is a direct replacement. Although new ignitors and burner management system are strongly recommended options, they are not fundamental to the burner's operation and the retrofit can take place without them.

In-situ sulfur control had been investigated by FWEC over a decade ago when 50-60% sulfur capture was obtained on an 80 MW utility steam generator. A lime-based hydrate system was used for that demonstration. More recently, systems based on combining low NO_x burners with pulverized limestone have

been investigated by numerous researchers. Information on both techniques, both in-house and external, have been evaluated as part of this investigation. A key conclusion is that there is, at the present time, insufficient data with North American bituminous coals to justify a definitive choice between the systems with standard commercial guarantees expressed for sulfur capture.

Since the sorbent handling system would be the same for either pre-pulverized limestone or lime (the lime-based hydrate system requiring only the addition of a hydrator and some auxiliary equipment), the former system is recommended. The system offered injects limestone particles to the outer secondary air annulus and is adjustable so that the position of the limestone"spray" relative to the flame can be optimized for highest SO_2 capture at minimum Ca/S mole ratio. The system can be easily modified to inject the pre-pulverized limestone directly into the coal conduit, downstream of the pulverizer. It is possible that the low furnace zone temperatures of this particular boiler, which will be even lower with the CF/SF burner, may obviate the need for the secondary air limestone injectors.

We are quite confident that the goals of this program, 50% NO_x reduction and 50% SO_2 capture at Ca/S of 2.5, can be achieved with this system.

1.0 THE COAL BURNERS

1.1 Burner Design

Foster Wheeler will supply two low NO_x coal burners. The burner design is FW's Controlled Flow/Split-Flame (CF/SF) pulverized coal burner which is our standard commercial offering for steam generators which must conform to NO_x emission limits. The burner is shown schematically in Fig. 1.1. The burner can be retrofitted with a minimum of modification to the heating plant, and without compromise to the burner's ability to reduce NO_x. Drawing No. 51-4476-5-650, attached, shows the CF/SF burner as configured for the Gagetown boiler.

This design was chosen in response to the requirements of the Department of Supply and Services' RFP. That is, it is a commercial design, as stated above, which has been used in strictly commercial applications. There are no developmental or experimental aspects to this burner as it has been in commercial utility operation, in both new and retrofit applications, since 1979.

In comparison, the Distributed Mixing Burner (DMB) concept being developed by the U. S. Environmental Protection Agency (EPA) and others is still experimental. It has not demonstrated any advantage in NO_x control. The DMB, being an externally staged design, is more expensive to install as it requires installation of tertiary air ports as explained in Section 3.3.

FW Low NO_x Burner Description

Design features of the Controlled Flow/Split-Flame burner are as follows:

1. A split flame coal nozzle which partially separates the primary air from the coal into four dense coal streams. The air present in the initial stages of combustion is substoichiometric, allowing the coal to devolitilize in an oxygen-deficient region, thereby permitting fuel-bound nitrogen to convert to N_2 rather than NO. The four distinct coal streams retain their identity up to about two burner throat diameters into the furnace.

   The coal nozzle contains an adjustable inner tip which permits the primary air and coal velocity for each burner to be optimized with respect to the secondary air velocity, for optimum NO_x control.

2. Two sets of secondary air registers are provided to precisely control secondary air swirl and the rate at which the air enters the flame.

3. Perforated plate air hood evenly distributes the air circumferentially around the register opening. In combination with air pressure measuring taps across it, the plate acts as an orifice meter and indicates relative secondary air flow between burners.

4. The movable sleeve provides the means to control the air flow without affecting the swirl induced by the registers. This is important to balance the air flow to each burner independently without the need for a segmented windbox.

5. Low turbulence design features have been incorporated into the shape of the airways, rounded corners and longer radius curves.

It is important to note that after startup and final burner optimization only the outer register is controlled by the burner management system and has a motor operator drive. No further adjustment is necessary or recommended to the movable sleeve, inner register or the variable velocity coal nozzle, and only manual drives are provided for these. This means that the burner is no more complicated to operate than a conventional burner once it has been properly set up.

1.2 Low NO_x Burner Background

Foster Wheeler has developed a low NO_x burner that is commercially installed and operating in three facilities and has been standard equipment on boilers sold since 1979. This burner has demonstrated that large reductions in stack NO_x concentrations are obtainable strictly by modification of the combustion process. It has achieved this result over a wide range of boilers from a small test boiler to a 550 MW utility boiler. In addition, a large body of information on the injection of limestone in the furnace for the in-situ absorption of SO_2 has been developed by FW and others. This information has shown that significant SO_2 reductions may be obtained without the use of a costly flue gas scrubber system at the back end of the boiler.

1.2.1 Evolution of Low NO_x Coal Burners

In 1971 the United States Environmental Protection Agency established the New Source Performance Standards (NSPS) which initially limited NO_x to .7 lb/million Btu input for new coal fired central station steam generators. This regulation could be met with the high turbulence pre-NSPS burner design by enlarging the combustion zone to reduce flame temperature and reducing the burner stoichiometry with air ports to stage the combustion. FW used this technique on industrial and utility boilers until 1976, after which low NO_x burners were offered. High turbulence burners, such as those at Gagetown, were designed to burn coal with a hot flame to minimize unburned combustible loss. Unfortunately, this approach also produces high NO_x levels.

A high turbulent burner design was originally installed on Public Service of New Mexico's San Juan Unit 1 with over fire air ports to control NO_x. This method reduced NO_x 30 to 35% by reducing burner stoichiometry to no less than 96%. While this was adequate to meet the federal EPA standard, a 60% reduction was necessary to meet the State of New Mexico's limit of .45 lb/million Btu. This large reduction would have required lowering burner stoichiometry to about 75%. Such a strongly reducing atmosphere in the lower furnace could increase slagging and tube wastage, as well as increasing unburned carbon, CO and hydrocarbons. The unit was, instead, retrofitted with the Controlled Flow, Split Flame (CF/SF) burner, which meets the New Mexico regulation without using air ports. Figures 3.3 and 1.1 respectively, show the burner configuration and the test results for San Juan Unit 1.

The predecessor to the CF/SF burner was the Controlled Flow (CF) burner. It was similar in design, except it lacked the splitter provisions in its movable nozzle. It was developed on a four-burner industrial unit, producing a 40% reduction from the originally installed high turbulence burners. Later, the split flame coal nozzle was added and tested on this same unit, yielding a reduction of 60% to 70%. Figure 1.2 summarizes these developmental test results.

Both burner designs were also tested on a single burner fifty million Btu/hr test facility. Figure 1.2 contains comparative data from these tests. Note the close correlation in results between the four-burner unit and the test facility. The test facility, operated by Foster Wheeler's Japanese

licensee, Ishikawajima-Harima Heavy Industries (IHI), is illustrated in Figure 1.3 Table 3.2 compares the specifications of the IHI test facility with those of the Gagetown units. Note that they are very similar, demonstrating that the IHI facility's results should be closely duplicated by Gagetown.

An advanced design CF/SF burner has also been tested in the IHI facility. Figure 1.2 shows that without overfire air NO_x has been reduced to .25 lb/million Btu. Over fire air ports, reducing the burner stoichiometry to 96%, dropped the NO_x level even further to .185 lb/million Btu.

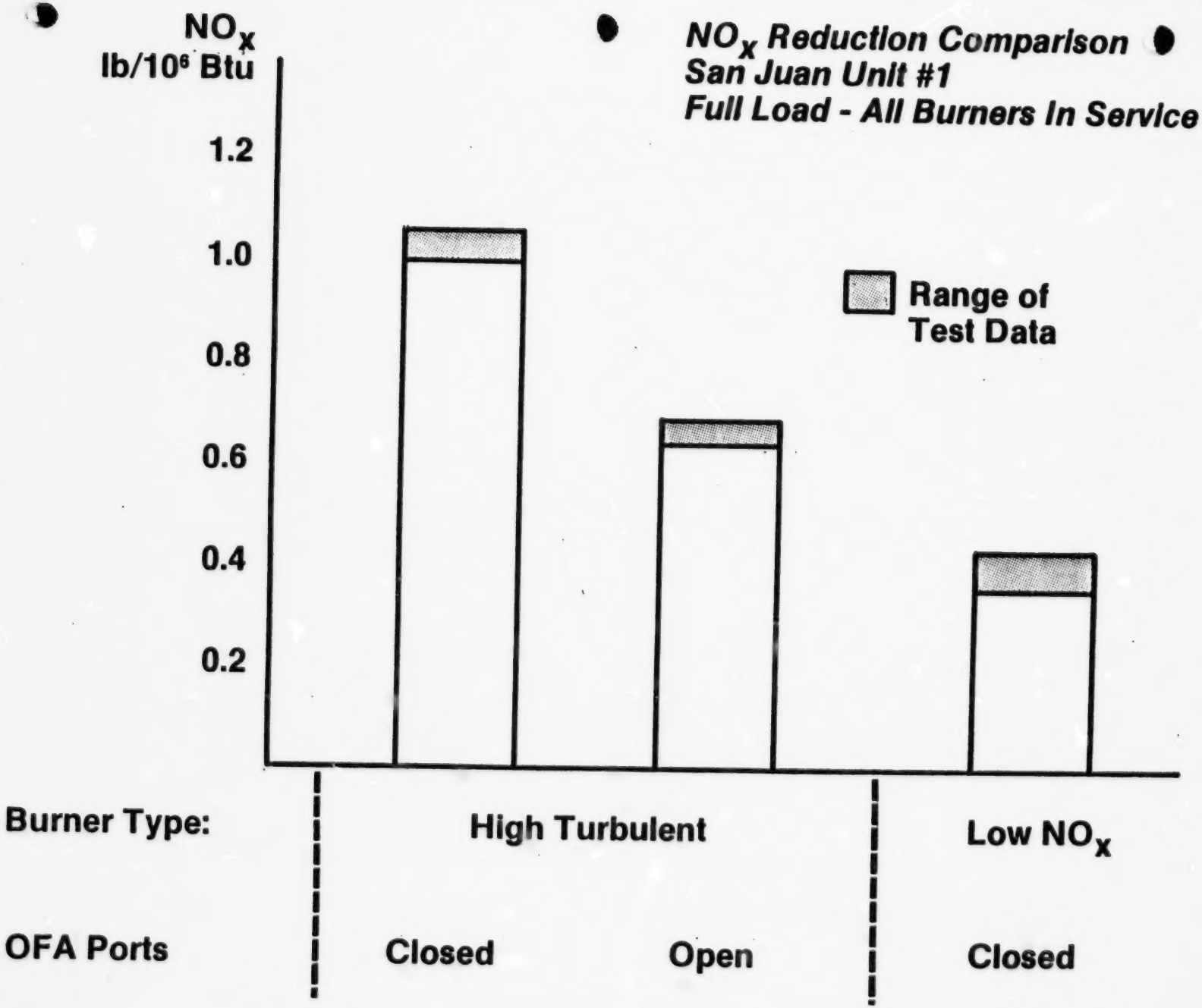
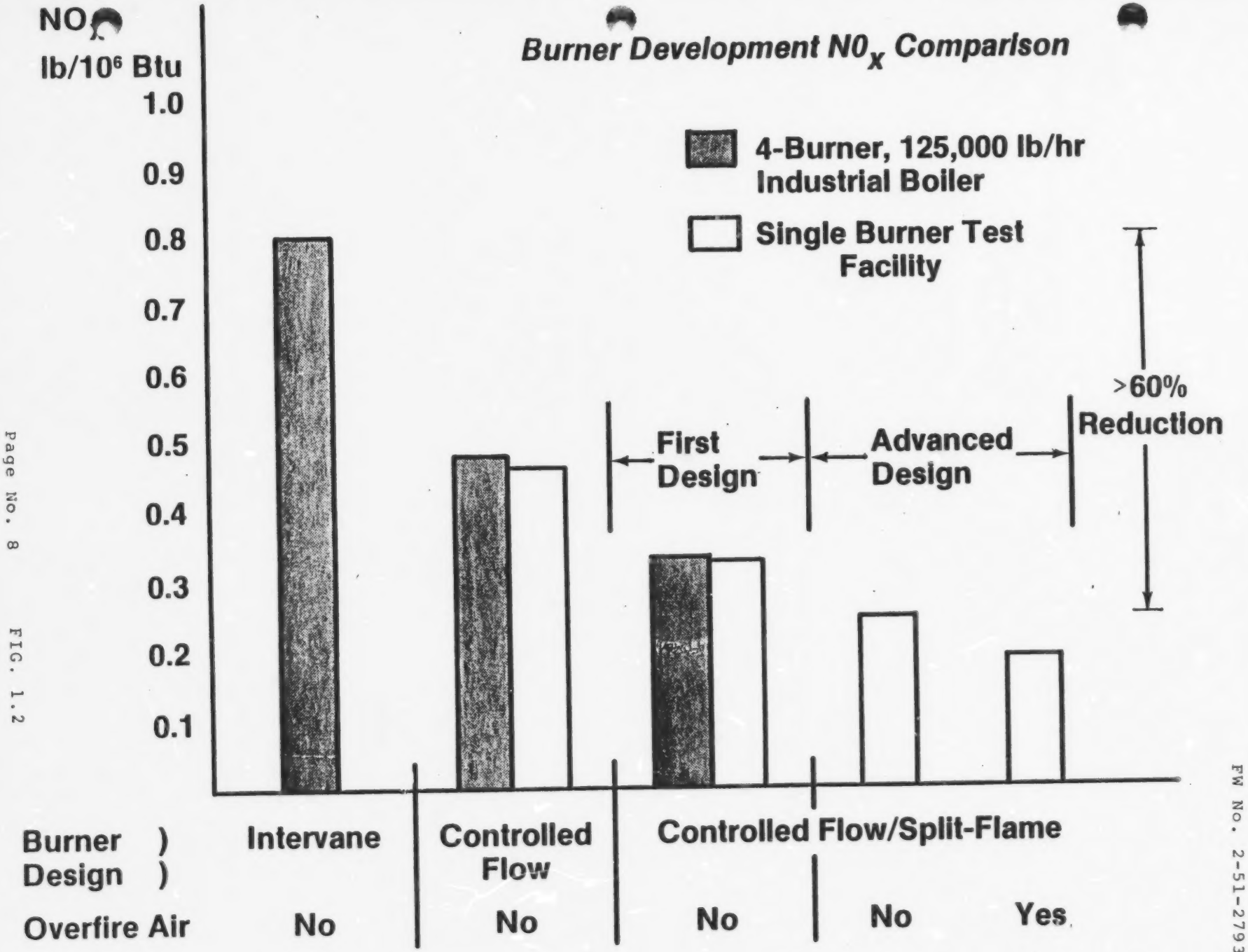


FIG. 1.1

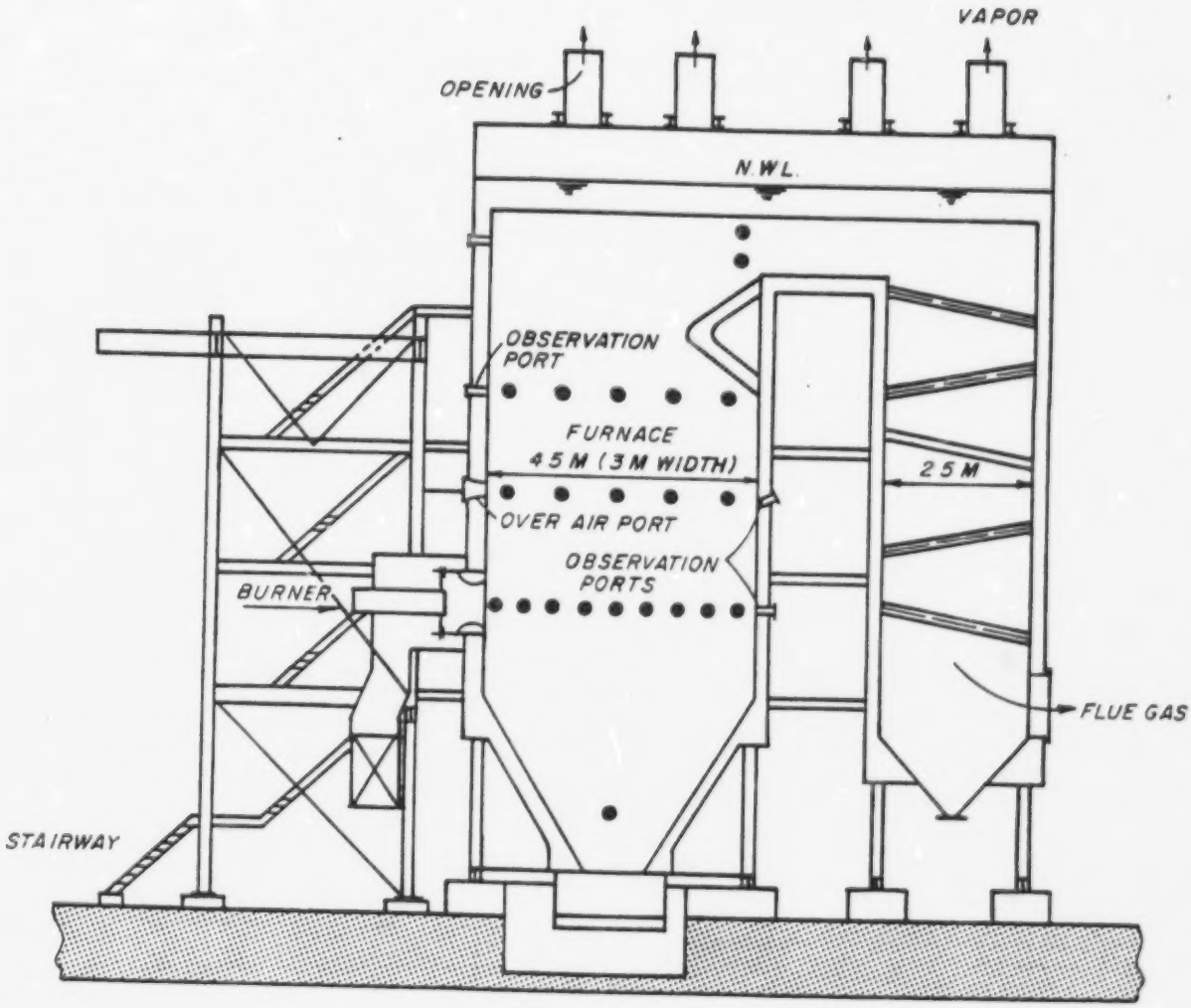
FW No. 2-51-2793



Page No. 8

FIG. 1.2

FW No. 2-51-2793



IHI COAL FIRED TEST FACILITY

FIG. 1.3

1.3 Burner Installation

The CF/SF burner will require a slightly larger windbox opening than the OEM burner. The throat is smaller in diameter and has a substantially different geometry, necessitating a complete replacement of the refractory materials in this area. The burner coal inlet has been designed to be coupled to the existing conduit without any modification to the conduit. Drawing 51-4476-5-650 shows the layout.

Due to the poor quality of the OEM drawings and lack of details on the construction of the unit, the exact details of the installation will have to be worked out after an inspection of the unit. The weight which the windbox front plate and the boiler casing within the windbox can support must be determined. FW's register must be supported off the casing, while the OEM register appears to have been supported by the windbox front. FW's estimate assumes that additional support will be needed for the register. Details are also lacking on the boiler's structural support, the refractory brick between the furnace tubes and casing, the method of support for the furnace tubes, and so forth. This information is important for determining the structural aspects of the design and the exact installation method.

1.4 Burner Operation for Emission Control

The burners will initially be operated at pre-determined baseline settings of the adjustable mechanisms. The sliding sleeve dampers will be fully open to provide minimum windbox to furnace pressure drop. The register positions will be varied to find the optimum setting for NO_x and SO_x at minimum CO and O_2 levels. The sliding nozzle tip will then be adjusted for further emissions optimization. Extending the tip towards the furnace increases the coal/air velocity, while retracting it has the opposite effect. If an air flow imbalance exists between the two burners, the sleeve dampers can be adjusted to balance the flow.

Foster Wheeler will perform this burner optimization in a logical, stepwise procedure, as is normally done in any other startup of Foster Wheeler's commercial contracts. The sliding tip, inner register and the sleeve damper will be left in their optimum positions. Only the outer register will have to be moved, either manually or remotely, during operation. If the recommended burner management system is installed, this register can be positioned automatically with the push of a button on the control panel. Only 3 different positions would be used. "Closed", for when the burner and ignitor are out of service, "lightoff", for ignitor only or low load coal operation, and "open" for up to full load operation. These last two positions will have been derived from the optimization during startup, and will be important to optimum emission control and flame stability.

Foster Wheeler normally designs its coal firing systems for a maximum primary air to coal ratio of less than 2:1 at full load. Coal

conduits are then sized so that the resulting primary air velocity will be high enough to prevent coal from settling out in the conduits. The conduits at the heating plant are too large to hold to this air/coal ratio. Therefore, we have designed the burner for an air/coal ratio of 3:1 which will prevent the coal from settling out. Instrumentation in the burner management system will provide an indication of primary air flow to each burner, which can then be correlated to coal feeder speed settings to maintain the proper air/coal ratio.

The mill outlet temperature should be maintained at a maximum of 175°F for the primary air flow specified. A heat balance on the coals specified in G. A. Robb Associates report shows that the coal can be sufficiently dried with the primary air temperature available (about 300°F during 3/82 tests). This coal pulverizer exit temperature is typical for virtually all Foster Wheeler coal fired systems burning similar coal

Initially, furnace gas will not be used, unless the coal is too wet to be dried using only hot air. The effect of using furnace gas in the primary air on NO_x, SO_x capture, CO and flame stability is unknown with the OEM burner design. The CF/SF burner has been tested with flue gas recirculated to the primary air. Flame stability problems occur only at high levels of gas flow. To test this effect at Gagetown hot primary air could be reduced while the furnace plug valve is opened, along with the tempering air damper. The pulverizer exit temperature would then be maintained under control, while still

controlling the air/coal ratio to prevent loss of flame.

The effects on the presently installed burners is difficult to gage with any certainty, since there have been no measurements of air or gas flow into the pulverizer. Interviews with the plant operators revealed that hot and cold primary air and furnace gas flows are only regulated into order to maintain the unusually high pulverizer outlet temperature. The operators say this high temperature is used to ensure drying the coal and to prevent plugging the raw coal inlet to the mill.

Foster Wheeler's experience is that it is not necessary to dry the coal so severely. It is only necessary to drive off the surface moisture, which the 175°F mill exit temperature will do more than adequately. Furthermore, the coal analyses shown in G. A. Robb Associates' report indicate relatively dry coal.

It does not seem likely that the use of an unusually high pulverizer exit temperature will prevent plugging the raw coal inlet to the pulverizer. This is more likely to be a function of the draught in the pulverizer, which is maintained slightly below atmospheric (-30 to -45 Pascals observed during 3/82 tests). Since the furnace is maintained at a slightly negative draught, then the mill must be at an even lower pressure to pull in the furnace gas. This same negative draught can be controlled by use of the dampers in the primary air ducts.

2.0 BURNER MANAGEMENT SYSTEM : EVALUATION AND RECOMMENDATION

Foster Wheeler recommends the installation of the optional burner management system described in this report. The specifications of Appendix "A" in the RFP requires the system to operate "without support firing". In order for any pulverized coal firing system to operate in a stable manner, certain operating parameters must be controlled. These same parameters will also affect NO_x and SO_x emissions. Parameters such as stable coal flow and the primary air to coal ratio must be monitored and controlled by a burner management system. The G. A. Robb Associates report on the March, 1982 baseline testing reports that oil was fired to "stabilize combustion and prevent explosions due to momentary interruptions in coal feed".

If the burners are to be operated as specified (i.e., without oil support), then a proper flame safety and burner management system must be utilized. Burner design cannot compensate for coal feed interruptions or improper air/coal ratios.

A loss of flame, for whatever reason, must cause an immediate termination of coal flow to the burner. Otherwise, continued coal and air flow into the furnace can easily result in an extremely destructive explosion. The burner management system proposed in this report will, in the event of a loss of flame, immediately trip the pulverizer out of service and close the burner shut-off damper on the mill outlet.

The burner shut-off damper is necessary for two reasons. It immediately stops the flow of coal from the pulverizer, and it prevents a flame front from travelling down the coal conduit into the mill.

The Forney IDD-II flame scanners used with this system are the proper design for detecting coal and oil fires. The predominant frequencies of thermal radiation from coal and oil fires are in the infra-red range of the electro-magnetic spectrum. The IDD-II is designed to scan this portion of the spectrum, to which it is highly sensitive.

The introduction of pulverized limestone into the furnace presents a problem with flame detection. The limestone sorbent will be introduced with the burner's secondary air, and will have some screening effect on the thermal radiation from the flame. To ensure detection of the flame, the scanner must be very sensitive to avoid false loss of flame signals.

The sensitivity of the detectors currently installed in unit 2 is likely to be inadequate. Operating without the bright core of flame in the near throat area produced by oil support, and with the limestone injection screening out some of the fire's thermal radiation, these detectors may not have enough sensitivity to detect the flame. This would, of course, create operating problems. False indications of flame loss may induce the operators to return to oil support, or they may ignore or react too slowly to an actual flame loss. The IDD-II scanner has adjustable sensitivity to overcome any screening effects of the sorbent injection. The sensitivity is adjusted to a proper level during start-up to prevent a false loss-of-flame indication if the fires should be a little weak, but not so sensitive that a flame is detected where one does not exist.

Equipment has been included to monitor primary air flow. Flame stability and NO_x are dependent on the velocity of the primary air and coal

mixture leaving the coal nozzle. During initial operation, the burner's slide nozzle is adjusted for the velocity which will yield optimum NO_x and flame characteristics. If the air/coal ratio is allowed to become too high, NO_x, SO_x and flame stability will deteriorate. If the air/coal ratio drops too low, then the coal will drop out in the conduit.

Flow will be monitored in the duct entering the mills, downstream of the tempering air inlets, so that total flow will be monitored.

3.0 SORBENT INJECTION

A complete evaluation of the alternative means of injecting a sorbent into the furnace was made. The three options for injecting the sorbent into the furnace are: dilute phase pneumatic, dense phase pneumatic, and pressure hydrated lime. After discussions with various suppliers of pneumatic conveying equipment the dense phase system was rejected. No supplier of dense phase systems was found who could supply a system that would deliver sorbant to two or more locations simultaneously. Although technically feasible, there appeares to be no market for such a system and it has not been developed. Consequently, no further consideration was given to dense phase transport. Acceptable suppliers of dilute phase pneumatic systems were found who have fully developed technology to inject limestone into multiple points.

A comparison of the relative merits of the pressure hydrate and the dilute phase pneumatic system was made and the following logic was used to justify the dilute phase pneumatic system:

1. The dilute phase pneumatic system has been used by U. S. EPA and has shown that 50% SO_2 capture is feasible using a limestone sorbant. Additionally, the FW-EPA test program, discussed in Section 3.2, will be performed on a pilot plant almost identical to the Gagetown heating unit.

2. Pressure hydrated lime in the size range 0.1 micron is commercially available and could be injected into the furnace using the dilute phase system. There are two caveats to this type of testing of 0.1 micron pressure hydrated lime:

a. Only dolomitic limes are commercially available. The dolomite and its hydrate must be tested for a comparison and from these tests an evaluation of the effect on particle size can be made. But these results cannot be completely generalized to a high calcium limestone (the recommended sorbent. See Section 3.4.); the results would only be indicative.

b. The difference in reactivity and particle size of the freshly made 0.1 micron pressure hydrated lime and the pre-prepared hydrate is not known. Hydrate made and directly injected into the furnace may be substantially more reactive than that made elsewhere and transported to Gagetown. Also, the particles may agglomerate during shipping, reducing their potential SO_2 capture.

3. Lime and its hydrate is roughly 6-7 times more expensive than limestone. The system should be designed for the cheapest acceptable sorbant. Contrawise more expensive sorbents may prove to have the highest SO_2 capture capability at Gagetown (regardless of the discussion in Section 3.4); hence, the testing of the more expensive sorbents should not be excluded in the sorbant handling system.

4. The pressure hydrator would require a lime handling system almost identical to the limestone system proposed. If, after testing commercially prepared 0.1 micron hydrate, the hydrator can be justified, it can easily be fitted into the limestone system.

3.1 Limestone Handling System

The limestone handling system (see drawing 51-4476-5-625) is designed to handle an average rate of 1040 lbs. of pulverized limestone an hour. This represents a Ca/S mole ratio of 2.5 using coal with 1900

ppm sulfur dioxide normal emission rate. Table 3.1 lists the scope of supply for the limestone system. The limestone silo is designed to be filled from a blower truck and it will hold 187 tons of limestone. The limestone is blown from the truck into the silo where the limestone separates and falls while the air vents through a baghouse at the top of the silo. A bin activator is used to assist the flow of the limestone from the silo. Very fine material has a tendency to bridge easily, interrupting the flow; the bin activator will prevent potential flow problems. The system is designed to handle limestone pulverized to a fineness of 95% passing through a 325 mesh screen. The silo is emptied via a rotary airlock. The limestone is transported to the day bin above the burner front at a rate of 9370 lb/hr using a pressure blower system. At this rate of transport the system must operate three hours a day to keep the day bin supplied. The blower is a 25 HP rotary positive displacement pressure pump developing a nominal 10 psig. The blower is located inside the heating plant building instead of under the silo, as is conventional, to allow for easier maintenance. The limestone is transported to the day bin where a filter separates the limestone from the air and the clean air is vented.

A silo dryer was evaluated because of the cold, humid environment in New Brunswick and the hygroscopic nature of the sorbant. A small amount of moisture condensing inside the silo would increase the tendency of the sorbant to bridge. Havelock Lime was consulted on this problem; they do not have silo dryers and see no need for one at Camp Gagetown.

The day bin is sized to hold 18 hours of limestone at the 2.5 Ca/S mole ratio. A bin activator is necessary to retrieve the limestone from the day bin and silo because the limestone's tendency to bridge. A rotary air lock is provided to meter the limestone. This type of feeder will consistently feed the same volume of material when operated at the same speed. A calibration curve must be developed to accurately determine the feed rate at any rpm. A gravimetric feeder can be added quite easily, at an extra cost, and is recommended for accurate determination of the limestone feed and for inventory control of the limestone. The feeder is designed to operate at a rate as low as 200 lb/hr and as high as 2080 lb/hr. This range in feed rate is necessary to accommodate low boiler loads and short term excursions of high SO_2 due to coal sulfur variability.

The limestone is fed into the distribution system which delivers the limestone to the burner. A 20 HP blower transports the limestone through one pipe in which the flow is progressively split in half 3 times, resulting in 8 outlets. Each burner will have 4 outlets for the limestone spaced around the outer secondary air annulus of the burner (see Figure 3.1 and drawing 51-4476-5-650).

This system is very flexible, each split can be adjusted so that either one of the outlet pipes can receive 0 to 100% of flow. The limestone flow can be biased to any one or any group of injection points. The injection pipes will have a directional device added at the tip of each pipe; this device will allow the limestone to be directed in any direction. The device will be adjustable during firing so that the optimum direction for SO_2 capture can occur. This will allow the limestone to be injected into the best location in the flame for the highest SO_2 capture.

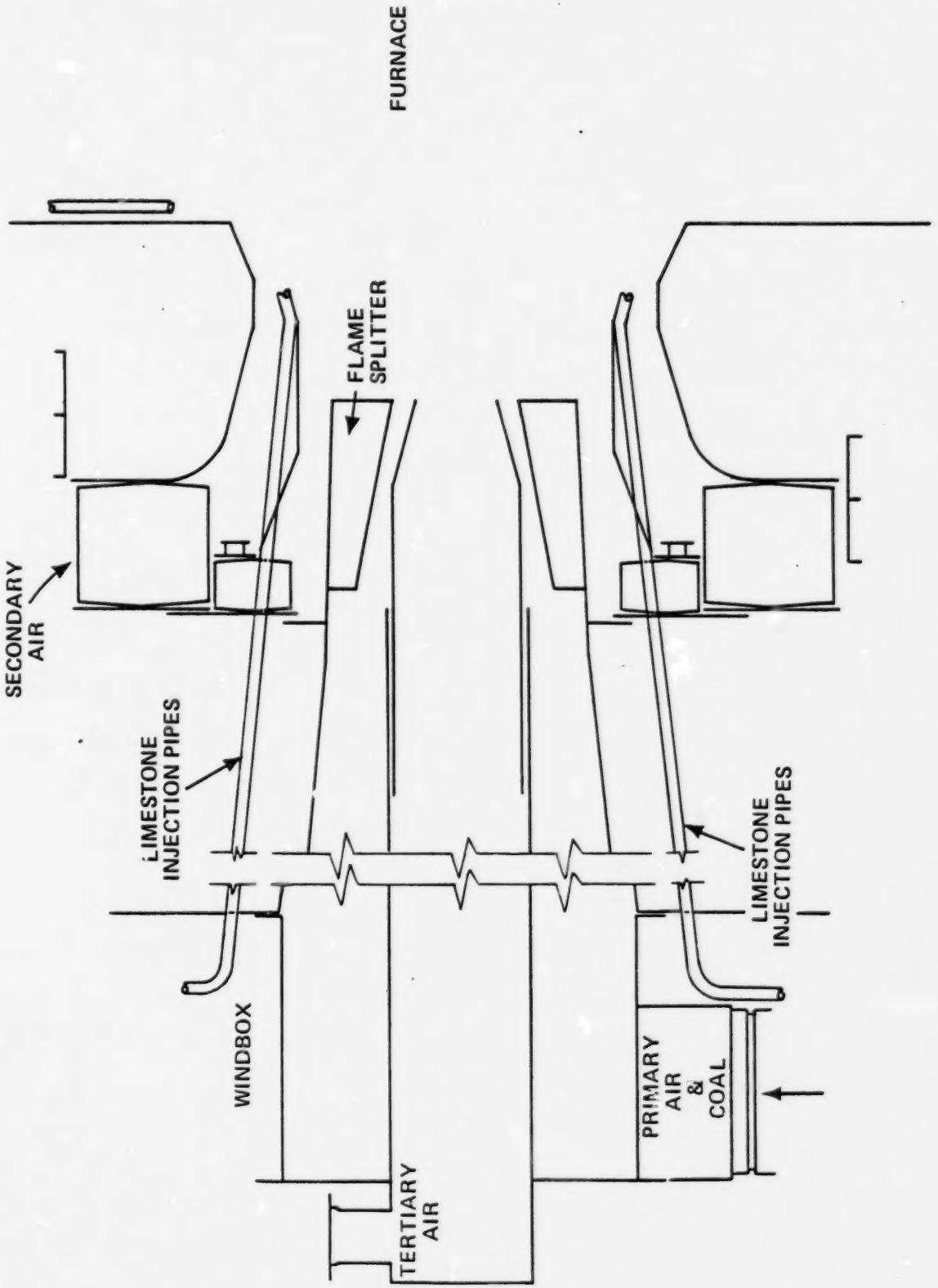


FIGURE 3-1 APPROXIMATE LOCATION OF LIMESTONE PIPES WITH IN THE CONTROLLED FLOW/SPLIT FLAME BURNER 2 SHOWN (OUT OF 4)

TABLE 3.1 LIST OF MATERIAL INCLUDED IN LIMESTONE HANDLING SYSTEM

Storage Silo, 4200 cu. ft. capacity, with ladder and cage

Dust Collector, (2) 115 sq. ft. of cloth area

Bin Activator, (1), 6' dia., (1) 3' dia.

Knife Gate Valve, maintenance valve for silo

Pressure Blower Package, (1) 25 HP, (1) 20 HP

Rotary Feeder, (1) 8", (1) 6"

Pneumatic Pipe, 252' 4" SCH 40

84' 3" SCH 40

84' 2" SCH 80

168' 1½" SCH 80

with ells, tees, and couplings

Level Indicators (5)

Control Panels (1) for Silo, (1) for Day Bin

Splitters, 1 4" x 3"

1 3" x 2"

4 2" x 1½"

Day Bin, (1) 226 cu. ft.

The system as shown is similar to many systems that FW has purchased in the last 5 years for its Fluidized Bed Boilers. We use this type system for flyash reinjection at multiple points in the fluidized bed. These systems have performed as guaranteed quite consistently and we are confident that this system will work as designed.

3.2 Location of the Injection Point

The location of the injection point can affect the ultimate SO_2 capture capabilities of the system. This point has been extensively studied and will be further studied by FW and the U. S. Environmental Protection Agency as part of a joint pilot program at FW's Japanese Licensee, IHI. The IHI pilot program is currently scheduled for March, 1983; scheduling problems set the program back 3 months. The current knowledge on this subject indicates that injecting the limestone with the coal may not be optimum. The final determination for the design of the Gagetown system whether to inject the limestone with the coal or through the outer secondary air annulus will be made after an evaluation of the data from the IHI tests. If it is determined that injecting the limestone with the coal is better, then the limestone can be injected into the primary air conduit between the pulverizer and the burner. This arrangement would not affect mill capacity and the limestone system can be easily modified to suit.

The data from this test program will be particularly applicable to the Gagetown system. The pilot plant at IHI will be using the same burner design and almost the same burner size. The FW CF/SF burner, although never before tested for SO_2 capture with limestone injection,

is exceptionally suited for this service. The pilot plant also has a similar heat liberation per radiant heat transfer surface. Table 3.2 compares the Gagetown system with the IHI pilot plant. A comparison of the coals and limestone to be used for this test program (Table 3.3) shows that both the coal and limestone are also very similar.

The current theory on the location of the limestone injection point hypothesizes that the optimum location is a balance between two criteria: the injection point should be close to the coal nozzle and the injected limestone should be exposed to an oxidizing atmosphere. Since the source of the SO_2 is the coal, close contact should be maintained between the SO_2 source and the sorbant. Close contact for a long residence time will maximize the utilization of the sorbant and the SO_2 capture efficiency.

The near throat portion of the flame is substoichiometric and is the zone where the peak flame temperature occurs. The Controlled Flow/Split-flame (CF/SF) burner is designed as an internally staged burner. Internal staging reduces both thermal and fuel NO_x formation and lowers the peak flame temperature. Injecting the limestone with the coal will cause it to pass through the hottest part of the flame. This injection point will increase the potential of dead burning the lime unless peak flame temperatures are below 2400°F. However, the lime is less likely to be dead burned with the CF/SF burner than with a conventional burner because of the reduced peak flame temperature of the former. FWEC has measured peak flame temperatures, on the 40 million Btu/hr prototype, in the range of 2100-2400°F depending on burner adjustments. NO_x variation is less than 10% in this range.

TABLE 3.2 COMPARISON OF IHI PILOT PLANT WITH THE DND GAGETOWN BOILER

SYSTEM	ITEM	GAGETOWN	PILOT PLANT
FURNACE	Width	10.5 (3,200 mm)	10.2 ft (3100 mm)
	Depth	16 ft (4,880 mm)	14.8 ft (4500 mm)
	Height	38.7 ft (11,800 mm)	36 ft (11,000 mm)
BURNER	Type	FW-CF/SF	FW-CF/SF
	Max. Liberation	43×10^6 Btu/hr	50×10^6 Btu/hr
	Number	2	1
	Burner Zone Sensible Heat Liberation	70×10^3 Btu/ft^2-hr	65×10^3 Btu/ft^2-hr

An oxidizing atmosphere is important because of the reaction kinetics of the SO_2 lime reaction. The reaction of SO_2 with limestone requires oxygen to proceed to completion.

$$CaCO_3 \xrightarrow{\text{heat}} CaO + CO_2 \qquad (1)$$

$$CaO + 1/2\ O_2 + SO_2 \longrightarrow CaSO_4 \qquad (2)$$

Various studies of this reaction have shown that the sulfation reaction proceeds as in reaction 2 and not as implied by reaction 3 and 4.

$$CaO + SO_2 \longrightarrow CaSO_3 \qquad (3)$$

$$CaSO_3 + 1/2\ O_2 \longrightarrow CaSO_4 \qquad (4)$$

The reaction rate is proportional to the concentration of SO_2 and $\underline{O_2}$, this means that both oxygen and SO_2 must be present simultaneously for the reaction to proceed. In a localized reducing atmosphere all the oxygen is tied up with CO or CO_2; hence, the reaction cannot proceed until oxygen is provided.

The Foster Wheeler CF/SF burner is designed to minimize the amount of air, near the burner throat, that the coal stream is exposed to and yet still burn the coal completely. Just enough air is added in the primary air and the inner register to maintain combustion. The air from the outer register shrouds the reducing combustion zone and completes the combustion. We propose that the best location for injection of limestone is in the inner edge of the outer secondary air

register. At this location the limestone is mixed rapidly with the combustion products of the inner flame zone just as they are leaving this zone. This location maximizes the O_2 concentration required by the reaction while maximizing the contact time of the limestone and SO_2 and permits the limestone particle to calcine without passing through the peak flame temperature zone.

3.3 EPA Test Results

Limestone injection was tested at the EPA pilot facility, the Large Watertube Simulator (LWS). The burner system used in this test is the Distributed Mixing Burner System (DMB). This burner system is a combination of FWEC's Controlled Flow burner and tertiary air ports. The LWS and the DMB are shown in Figure 3.2. The Controlled Flow burner is similar in design to the CF/SF burner (see inset, Fig. 3.3) except it does not have the split flame nozzle. The tertiary air ports are four air ports arranged symmetrically around the burner; about 50% of the secondary air flows through the air ports.

The U. S. EPA has tested the SO_2 capture of this burner when limestone is injected into the mill and into the tertiary air ports. The results of this program showed that at a Ca/S mole ratio of 2.5, 45% to 55% SO_2 capture was achieved by injecting the limestone through the mill and tertiary air ports, respectively. This was achieved using a 2.4% sulfur Indiana coal and the limestone to be used at IHI as shown in Table 3.3.

The same effect as injecting the limestone through the tertiary air ports (TAP) can be achieved by using the CF/SF burner and the proposed limestone injection system. By injecting the limestone

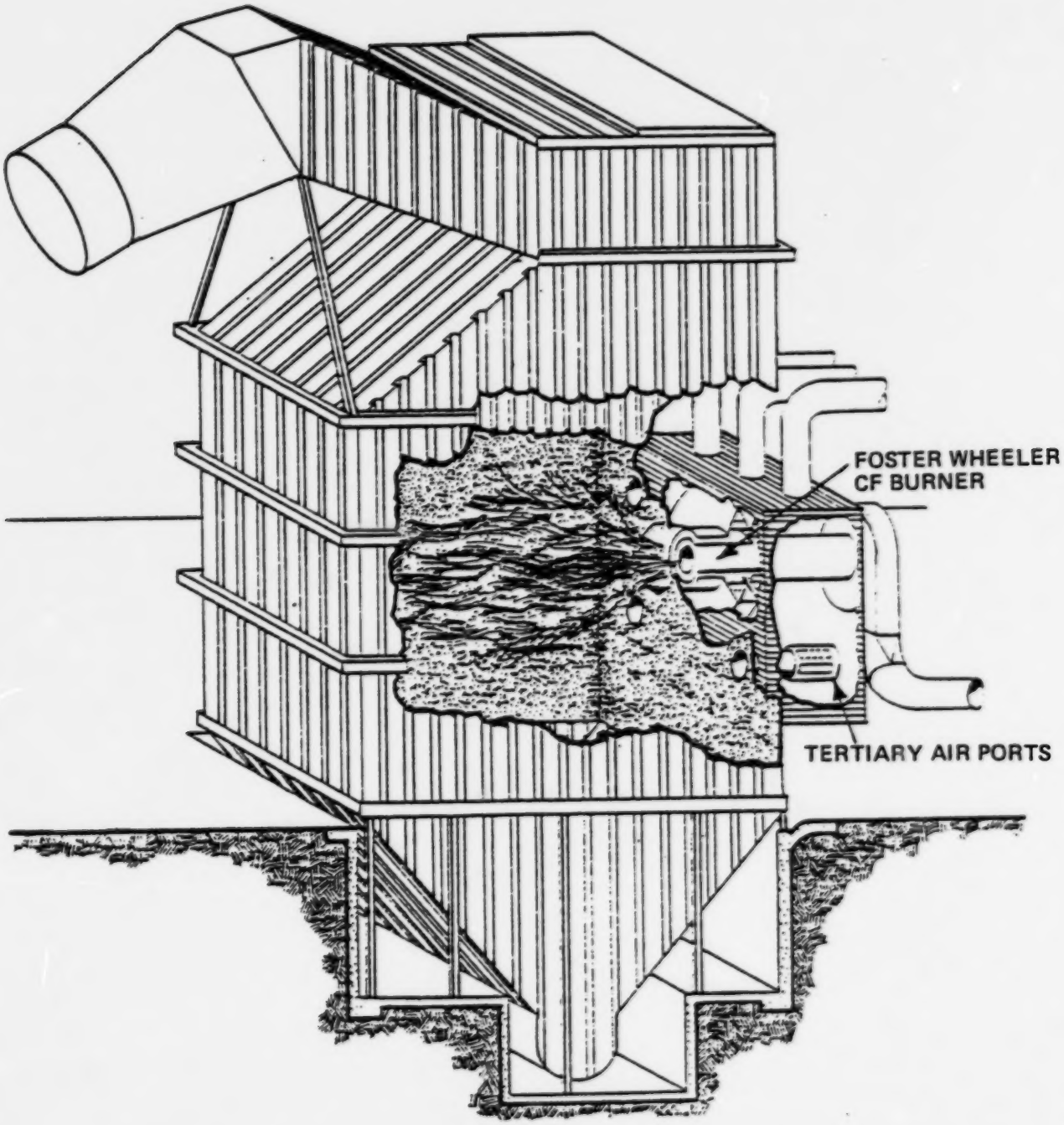


FIGURE 3 - 2 THE U.S. EPA LARGE WATERTUBE SIMULATOR

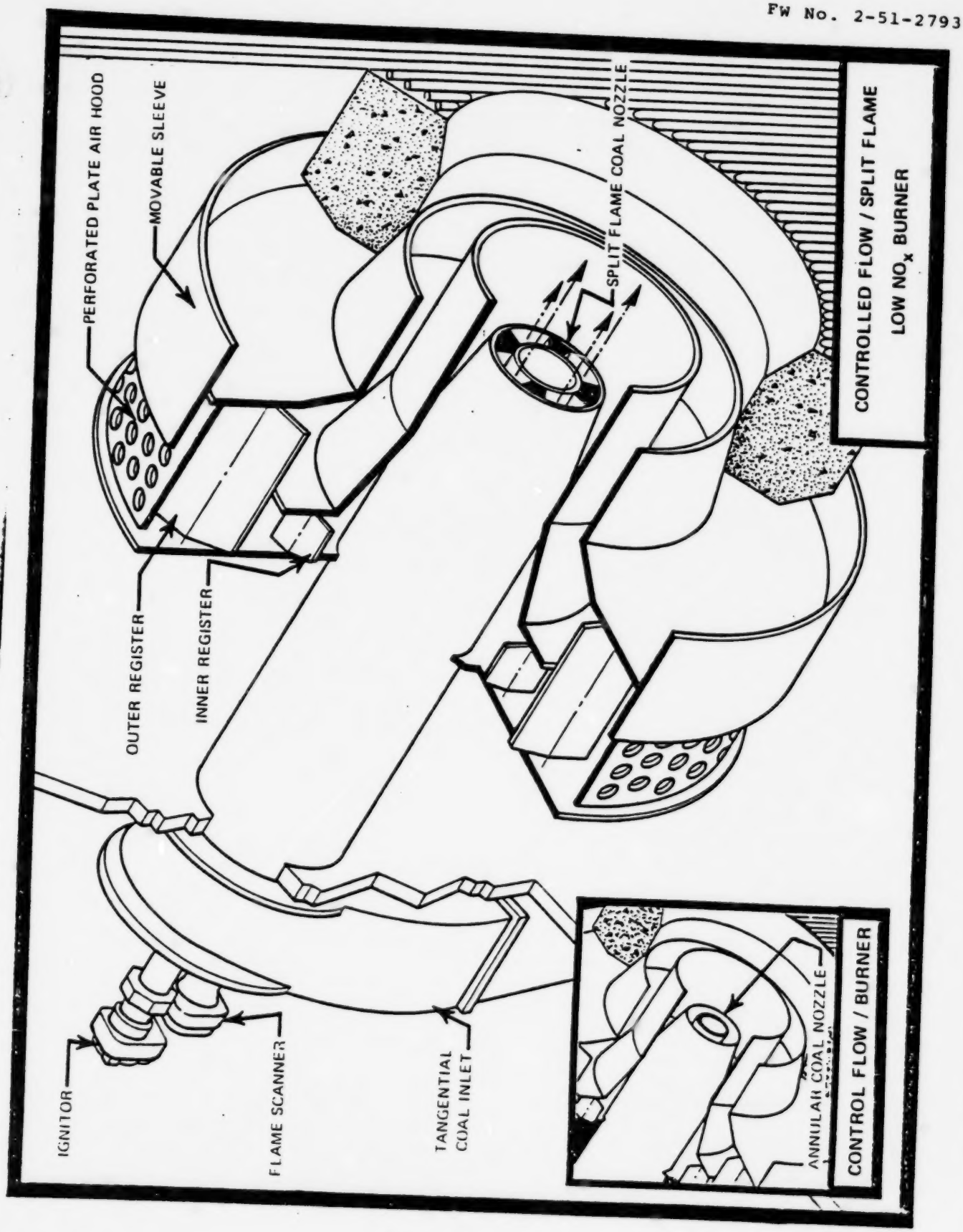

CONTROLLED FLOW / SPLIT FLAME
LOW NO_x BURNER
PERFORATED PLATE AIR HOOD
MOVABLE SLEEVE
SPLIT FLAME COAL NOZZLE
OUTER REGISTER
INNER REGISTER
IGNITOR
FLAME SCANNER
TANGENTIAL COAL INLET
CONTROL FLOW / BURNER
ANNULAR COAL NOZZLE

FIG. 3.3

TABLE 3.3 A COMPARISON OF COAL AND LIMESTONE USED AT GAGETOWN TEST AND AT THE FOSTER WHEELER-U.S. ENVIRONMENTAL PROTECTION AGENCY TESTS AT IHI

Coal Analysis, As Received
Proximate Analysis, % by Weight

	Gagetown Test Fuel March, 1982	IHI Test Fuel
Moisture	1.5	6-7
Ash	8.5	10-11
Volatiles	32.2	34-36
Fixed Carbon	57.8	50-51
Sulfur	2.6	3.5

Limestone Analysis, % by Weight

	Gagetown Test March, 1982	IHI Test Limestone
CaO	53.6	54.3
MgO	0.1	.76
SiO_2	1.8	1.0
Al_2O_3	0.2	0.15
$Fe2^0_3$	0.4	0.05
H_2O	0.1	0.2
LOI	43.0	43.5
TiO_2	0.2	not available
P_2O_5	0.1	not available
Na_2O	0.1	not available
R_2O	0.1	not available

through the TAP the limestone is maintained in an oxidizing atmosphere outside the peak flame temperature zone as it is calcined, and SO_2 capture subsequently occurs. But the TAP are quite far from the burner; the limestone and the flame do not mix until the coal is almost completely burned out. The optimum location is a very controversial subject but as discussed in Section 3.2, is as close as possible to the flame center line while maintaining the limestone in an oxidizing atmosphere. This can be effectively achieved by the CF/SF burner and the limestone injection system. Additionally, in the CF/SF burner the limestone injection direction can be changed to either direct it away from the flame center line and into a more oxidizing atmosphere or directed inward toward the flame closer to the source of the SO_2. Directing the limestone to its maximum radially outward direction using the CF/SF system would, in fact, closely simulate the injection of the limestone through the TAP.

In summary, the CF/SF burner in combination with a limestone injection system that has directional adjustability should achieve optimum SO_2 capture and sorbent utilization. Additionally, the CF/SF burner can be easily retrofitted while the TAP requires a new windbox and major structural and pressure part changes. This discussion only covers the advantages of the SO_2 capture portion of the proposed CF/SF burner-limestone injection system. The advantages of the CF/SF burner over TAP in NO_x reduction are discussed in Section 1.0.

3.4 Choice of Sorbent

The candidates for sorbent selection are the following: Limestone, $CaCO_3$, Calcium Hydroxide, $Ca(OH)_2$, lime, CaO. Each of these three choices include the choice of dolomite or high calcium limestone.

Dolomite vs. Calcite Limestone

The reactivity of dolomite vs. high calcium limestone has been studied, both experimentally and theoretically. Experimentally, it has been shown in pilot tests that dolomites can be as reactive as high calcium limestone, but thermodynamically it has been shown that at the high injection temperature expected (2,000°F) $MgSO_4$ cannot form. At lower temperatures (1400°F) it can form but the reaction rates are much slower and the product formed is insignificant at the residence times expected in this temperature regime. This is a very controversial area. Many researchers feel a significant amount of $MgSO_4$ is formed in the 1400°F range. Magnesium in the dolomite may create conditions where a $CaSO_4$ shield is not formed over the particle surface. With a diffusion path into the center of the particle sulfation can continue utilizing much of the calcium but none of the magnesium.

The dolomites may have higher calcium utilization but the calcites have more calcium. If the MgO does not absorb SO_2, then more dolomite would be required to capture the same amount of SO_2. The increase would depend on the amount of magnesium contained in the dolomite. The extra dolomite required could add a substantial amount to the operating cost of the system.

Limestone/$Ca(OH)_2$/Lime

The choice of limestone, $Ca(OH)_2$ or lime has also been studied ex-

tensively in the literature with pilot testing both domestically and in Europe. In summary, the SO_2 absorption capacity is essentially the same for limestone and $Ca(OH)_2$ and slightly lower for lime, but the maximum absorption for limestone can be 752°F higher than the maximum for $Ca(OH)_2$ or lime (2732 vs. 2102). Other researchers, such as Potter, 1969 showed a 500 degree difference with a limestone maximum at around 2000°F.

Since calcination is a time-temperature related reaction, a perfectly calcined lime would then be dead burned or at least over-calcined when injected into the furnace. Over-calcination is known to reduce reactivity of the lime particle; hence, the lime would immediately start over-burning upon injection. A hydrate or a limestone in contrast would reach a temperature plateau during the calcination step as the H_2O or CO_2 is exfoliated from the lime, after which the temperature would rise. The limestone would require either a longer time or a higher temperature for the calcination to be complete, since limestone requires roughly twice the energy of the hydrate to calcine. Hence, the limestone could sustain a higher or longer time-temperature period without deactivation. This higher time or temperature would be very important in minimizing deactivation as the limestone is passing through the peak temperature regime of the flame. Based on the greater resistance that limestone has to dead burning when injected into the furnace, the recommended sorbent choice would be limestone.

Notwithstanding the above argument for limestone, other sorbents should be evaluated. The Gagetown furnace is cool relative to other larger boilers where injection was tested. Temperatures re-

sulting from the cool furnace and the low peak flame temperature of theCF/SF burner may be low enough that a hydrate or even a lime would not be dead burned. At a minimum, the controversial dolomitic limestones should be tested for comparison to the high calcium limestones.

4.0 CONSTRUCTION SEQUENCE

1. Set up, offload tools and equipment.
2. Offload burner & limestone components.
3. Remove burners & associated piping.
4. Remove coal conduit.
5. Remove front windbox plate.
6. Remove burner throats.
7. Erect scaffold & rigging as required.
8. Place & bolt up register assembly.
9. Move & place windbox front.
10. Fit & weld windbox front.
11. Fit burner piping.
12. Erect, fit & weld coal piping to burner.
13. Fit limestone injection piping at windbox.
14. Place insulation & lagging on windbox front plate.

EQUIPMENT INSTALLED BY F.W. LTD.

Storage Silo

1 - 12' diameter x 37' of cylinder with a 60^{o} conical hopper flanged to a 6' diameter opening. Unit will be constructed of welded carbon steel with plain interior and prime coated exterior. Unit will have 4200 cubic feet of storage capacity. The following accessories are included:

a) One (1) Bin activator mounting flange
b) One (1) OSHA ladder and cage assembly
c) One (1) Pressure/vacuum relief valve combination manhole
d) Three (3) Level indicator openings
e) One (1) Bin vent dust collector mounting flange
f) One (1) Guard rail and toe board assembly

Dust Collector

1 - Reverse jet dust collector of carbon steel construction where contact with product. Complete with integral air piping, compressed air header, diaphragm valves, aluminum venturies, epoxy coated bag cages, stainless steel bag clamps. 16 oz. Dacron filter bags, 115 sq. ft. of cloth area, quick opening access door, all welded housing, manometer, differential pressure switch and fittings. Solid state sequential timer and solenoid air valves prewired to a numbered terminal strip in NEMA 4.

Bin Activator

1 - 6' diameter bin activator of carbon steel construction complete with one piece forged steel hangers, oil lubricated gyrator, with a 1.5 HP direct inline motor drive, and 8" diameter discharge opening.

Knife Gate Valve

1 - 8" diameter manually operated knife gate valve of cast steel construction with 316 stainless steel contacts.

Truck Unload Pipe

1 - Lot of truck unload piping consisting of:

a) Sixty-three (63) feet of 4" Schedule 40 carbon steel pipe.
b) Two (2) 4" Schedule 40 x 90° carbon steel ells.
c) Seven (7) 4" steel pipe couplings with rubber gaskets.
d) One (1) 4" C.I. quick coupling assembly with dust cap, chain and limit switch.

Control Panel

1 - NEMA 4 truck unloading control panel complete with relays, pilot lights, selector switches, wiring, etc.

Pressure Blower Package

Rotary positive displacement pressure pump, cast iron construction. Complete with extended motor base support and OSHA drive guard. The pressure pump package will be furnished with an inlet filter, inlet silencer, discharge silencer, flexible connection, pressure relief valve, pressure switch and gauge, air pipe and fittings, driven by a 25 HP, 1800 RPM, 460 Volt, 3 phase 60 Hertz motor assembly. All blower packages will include sound treatment packages to ensure 90 dBA.

Rotary Feeder

1 - 8" PERMA/flo solids long life feeder of cast iron construction complete with externally adjustable rotor and shoe, cast of Permalloy 33 (550 Brinell). The unit has outboard bearings, lantern ring shaft seals, roller chain drive and an OSHA drive guard. The feeder is a reversing type driven by a ½ HP, 460 V., 3 ph., 60 Hz., gearmotor.

Pneumatic Pipe

1 - Lot of pneumatic conveying pipe consisting of:

a) One hundred eighty-nine (189) feet of 4" Schedule 40 carbon steel pipe.

b) Three (3) 4" x 90° PERMA/flo ells with Permalloy 33 removable wearbacks.

c) One (1) 8" x 4" PERMA/flo intake tee.

d) Ten (10) 4" steel pipe couplings with rubber gaskets.

e) Eight (8) 4" reducing couplings complete with rubber gaskets.

Use Bin

1 - Lime use bin, 6' diameter x 8' of cylinder and a 60° conical hopper flanged to a 3' diameter opening for bin activator mounting. Unit will be constructed out of A.S.T.M. - #283 grade C carbon steel plate. The total storage capacity will be 226 cu.ft. The following accessories are included:

a) One (1) 3' diameter activator mounting flange.
b) One (1) Pressure/vacuum relief valve combination manway.
c) Two (2) Level indicator openings.
d) One (1) Bin vent dust collector mounting flange.

Bin Activator

1 - 3' diameter bin activator of carbon steel construction complete with one piece forged steel hangers, oil lubricated gyrator with a .75 HP direct inline motor drive and 8" diameter discharge opening.

Level Indicators

2 - Top mounting model KA rotary paddle type level indicators complete with shaft extension and NEMA 4 electricals.

Level Indicators

3 - Model KA rotary paddle type level indicators designed for side mounting with NEMA 4 electricals.

Dust Collector

1 - Reverse jet dust collector of carbon steel construction where contact with product. Complete with integral air piping, compressed air header, diaphragm valves, aluminum venturies, epoxy coated bag cages, stainless steel bag clamps, 16 oz. Dacron filter bags, 115 sq. ft. of cloth area, quick opening access door,

all welded housing, manometer, differential pressure switch and fittings. Solid state sequential timer and solenoid air valves prewired to a numbered terminal strip in NEMA 4.

Rotary Feeder

1 - 6" Type B PERMA/flo solids long life feeder of cast iron construction complete with externally adjustable rotor and shoe, cast of Permalloy 33 (550 Brinell). The unit has outboard bearings, lantern ring shaft seals, roller chain drive and an OSHA drive guard. The feeder is a reversing type driven by a 1 HP, 230 V., single phase, 60 Hz. A.C. inverter gearmotor, variable speed drive package.

Pressure Blower Package

1 - Rotary positive displacement pressure pump, cast iron construction. Complete with extended motor base support and OSHA drive guard. The pressure pump package will be furnished with an inlet filter, inlet silencer, flexible connection, pressure relief valve, pressure switch and gauge, air pipe and fittings, driven by a 20 HP, 1800 RPM, 460 Volt, 3 Phase, 60 Hertz, motor assembly. All blower packages will include sound treatment packages to ensure 90 dBA.

Penumatic Pipe

1 - Lot of pneumatic pipe consisting of:

a) Sixty-three (63) feet of 4" Schedule 40 carbon steel pipe.
b) One (1) 4" x 3" carbon steel splitter.
c) Forty-two (42) feet of 3" Schedule 80 carbon steel pipe.
d) Three (3) 4" steel pipe couplings with rubber gaskets.
e) Two (2) 4" reducing couplings with rubber gaskets.
f) One (1) 6" x 4" PERMA/flo P-65 intake tee.

Control Panel

1 - NEMA 12 graphic control panel complete with starters, relays, time delays, terminal blocks, pilot lights, selector switches, mylar tape, wiring, etc.

OPTIONS

Pneumatic Pipe Splitters

2 - Lots of pneumatic pipe and splitters each consisting of:

a) One (1) 3" to 2" carbon steel splitter.
b) Two (2) 2" to 1½" carbon steel splitters.
c) Forty-two (42) feet of 2" Schedule 80 carbon steel pipe.
d) Eighty-four (84) feet of 1½" Schedule 80 carbon steel pipe.
e) Four (4) 2" steel pipe couplings with rubber gaskets.
f) Four (4) 1½" steel pipe couplings with rubber gaskets.

PRICE FOR COST PLUS FIELD WORK
(APPLICABLE FOR ADDITIONAL FIELD WORK ONLY)

The Purchaser shall pay to Foster Wheeler for the Field Work covering all material and/or services of a crew excluding the job superintendent, on a cost plus basis established in accordance with Foster Wheeler's standard accounting procedure, being the sum of the following items (1 to 10):

1. Materials - Cost of all incidental field materials purchased (e.g. welding rod, patch up refractory material, miscellaneous plate adapters; clips, etc.). This cost is the laid down cost at the site.

2. Field Labour - Cost for field labour at actual rates.

3. Erection Expenses - Assessments on erection payroll (excluding superintendents) such as vacation pay, unemployment insurance, Workmen's Compensation, welfare funds, public liability and property damage insurance premiums, etc., plus expendable tools, incidentals such as coveralls and gloves, and field materials such as scaffolding, fuels for compressors and welding machines, etc., commercial rentals, storage and services.

4. Mark-up - The total of items 1 to 3 will be subject to Construction Department overhead of 10% plus a mark-up of 10 %.

5. Sub-Contracts - The total cost to Foster Wheeler for all field sub-contracts executed in connection with this Field Work.

6. Overtime Premium and Shift - Premium on Foster Wheeler's overtime will not be included under any of the headings listed above, but the actual amount of premium paid without mark-up will be included under this item including assessments such as Workmen's Compensation and vacation pay on such overtime premium will be recorded under Item 3 herein.

7. Erection Tools - All erection tools supplied by Foster Wheeler, other than commercial rentals and expendable tools covered in Item 3 above, shall be on a rental basis as follows:
   (a) All shipping charges to and from site, including insurance where not provided by carrier.
   (b) Current Foster Wheeler rental rate based on replacement value of all erection tools.
   (c) Total cost less rental paid of any rental tools not returned in a useable condition.

8. Travelling and Living Expenses - Cost of travelling and living expenses paid to employees working on the job when same are normally allowed.

9. Overhead - The total of items 5 to 8 will be subject to Construction Department overhead of 10%.

10. Taxes - The amount of Federal, Provincial and/or Municipal taxes required to be paid by Foster Wheeler in connection with this Field Work.

11. Corrective Work - Except that resulting from defective or improper materials provided by the Purchaser for use by Foster Wheeler hereunder, shall not be subject to administrative allowance or mark-up.

12. Supervision - The services of a Foster Wheeler construction superintendent will be charged at a per diem rate for each basic 8 hour day. Premium time worked over 8 hours will be charged at hourly overtime rate per hour. Premium time charges will be applicable to Saturdays, Sundays and statutory holidays worked. Supervisor expenses will be charged as per item 8.
    Current rate $400.00 per working day; $75.00 per hour overtime.

    Rates in effect at time work is performed will apply.

CP-2.2

BUDGET PRICE BREAKDOWN

The budget price for the supply of equipment as outlined within this report, F.O.B. site, in Canadian Funds is $695,566.00

The budget price for the installation of equipment as outlined within this report, in Canadian Funds is $291,000.00

The budget price for the supply of flame safeguard system as outlined within this report, F.O.B. site in Canadian Funds is $276,172.00

The budget price for the installation of equipment as outlined within this report in Canadian Funds is $12,723.00

CFB GAGETOWN LOW NO_x - SO_x

BURNER RETROFIT

COMMENTS ON FOSTER/WHEELER DRAFT REPORT
WEDNESDAY, 23 March, 1983

QUESTIONS AND ANSWERS

A. GENERAL

QUESTION

1. Does the level of detail presented in the draft report, e.g., numbers of drawings, equipment lists, etc. represent all that will be available in the final report?

ANSWER

Yes, although more details are being made available as responses to these questions.

QUESTION

2. On page 10 it is stated that "due to the poor quality of the drawings and lack of details in construction of the unit, the exact details will have to be worked out after an inspection of the unit-----". Does this mean that the bid price is subject to change?

ANSWER

No, there will be no increase in bid price due to working out the final installation details as this work has been included in the pricing.

QUESTION

3. From the report, it appears that, in the course of commissioning, it may be necessary to modify several areas of the design, e.g. P18, a pressure hydrator to the limestone feed system; P20, change the limestone feeder to gravimetric; P23, change the injection point of the limestone. Should these and other changes be required, who pays and what would be the effect on the project schedule?

ANSWER

The pressure hydrator is not being proposed at this time. FW is reviewing this system for future discussion. The installation of a gravimetric feeder is recommended for more accurate determination of the limestone feed rate, but is not absolutely necessary for a workable system. The cost of the gravimetric feeder is included in the pricing and listed separately. If it is deleted, the price of the burner retrofit will be reduced by the amount listed for the feeder. The location of the limestone

injection point will be determined by the testing at IHI. Foster Wheeler's evaluation, as indicated in the report, is that the injection of limestone into the secondary air stream will be the better method. Should the IHI testing conclusively prove otherwise then there will be a price reduction based on the changes to the limestone injection system. None of these items will cause a schedule change.

QUESTION

4. The Foster Wheeler proposal stated that the design of the SO_x reduction system was dependent on the EPA test program with the CF/SF burner. What is the status of the program?

ANSWER

Due to coal delivery problems, this testing has been delayed until April 11, 1983.

QUESTION

5. Will the proposed burner meet the target NO_x and SO_x levels stated in the contract?

ANSWER

Target NO_x and SO_x levels stated in the contract will be met with the proposed burner.

QUESTION

6. The Foster Wheeler proposal stated that a recommendation would be made as to whether a sootblower should be added to the rear wall. Will this be necessary?

ANSWER

Foster Wheeler did not address this question in the report because the G. A. Robb Associates report on the March, 1982 testing stated that soot blowers would be installed on the boiler's back wall before the new burners would be installed. Foster Wheeler recommends that this be done, due to

the accumulation of deposits on the rear wall.

QUESTION

7. Temperatures should be given in ^{o}C.

ANSWER

Foster Wheeler has changed all temperatures in the report to ^{o}C.

QUESTION

8. Electric motors used should, if possible, be of the energy efficient type.

ANSWER

We are obtaining energy efficient type motors from Canadian suppliers for all equipment supplied by Foster Wheeler.

QUESTION

9. A spare parts list is required together with a priced list of parts expected to be required over the first two years.

ANSWER

We will supply recommended spare parts lists, with lead time for ordering, when all equipment has been designed. The recommendation will be for a two year supply of spare parts.

QUESTION

10. How many Operating and Maintenance Manuals are included in the price to be quoted?

ANSWER

Five Operating and Maintenance manuals will be supplied.

QUESTION

11. All electrical equipment should be of Canadian supply because of CSA approvals.

ANSWER

See the answer to question 8 concerning motors. Any other electrical equipment will be subject to availability in Canada.

QUESTION

12. Spare parts and service assistance must be available for equipment included.

ANSWER

Spare parts are available for all equipment supplied. Field service rep-

resentatives for start-up assistance are included in the price. The amount of field service time and cost are shown in the costs section (Section 5.0).

QUESTION

13. Any work on the boiler has to be done to the appropriate standards, e.g. ASME, New Brunswick Government Legislation, CSA etc. Is this included?

ANSWER

There will be no pressure part welding done on the unit. All work will be done according to applicable standards.

QUESTION

14. Comments on the mill exit temperature (P13) are accepted. However, at certain times of the year, the coal is wet enough to have water running from storage bins. This is when plugging of the mills occur.

ANSWER

Foster Wheeler recognizes the periodic wet coal problem and deals with it on pages 12 and 13.

B BURNER

QUESTION

1. On P1 it is stated that "the recommended new ignitors and burner management system are not fundamental to the operation of the burners"; then on P14 it is stated that "a proper flame safety and burner management system must be utilized". Can Foster Wheeler confirm whether the burner management system is required or not?

ANSWER

Foster Wheeler's position is that the new ignitor and burner management system being offered are necessary for safe operation. Although they do not play a fundamental role in NO_x and SO_x control, they facilitate achieving these ends through improved control of the burners' operation. The burner will operate satisfactorily as long as the proper air and fuel flows are supplied to it.

QUESTION

2. What is the status of the IHI tests?

ANSWER

Due to delays in coal delivery, the testing is now scheduled to start the week of April 11, 1983. Foster Wheeler expects to have a preliminary analysis by the end of May, with final analysis by mid-June, 1983.

QUESTION

3. It is not possible to quote a firm price for the burner management system cables to the master logic cabinet (P37)?

ANSWER

We will quote a firm price allowing for sufficient cable length.

QUESTION

4. A stable flame is essential from 25% to 100% load. Will the proposed system provide it?

ANSWER

The burners will operate with a stable flame from 25% to 100% boiler load. This is based on a turn-down ratio of 2:1 on each burner. Therefore, at 25% boiler load, one burner will be in service at 50% of its design maximum input.

QUESTION

5. In addition to the information given in the contract, it is necessary that the burners be capable of burning coals from various eastern Canadian mines without mechanical problems.

ANSWER

The burners can be fired with any eastern Canadian mined coal classified as Bituminous, except for the possible exclusion of low-volatile Bituminous. Classification is in accordance with ASTM standards. Sub-bituminous coals may also be acceptable, although they would need to be evaluated on a case-by-case basis.

QUESTION

6. Does the I and C package for the burners include all air flow measurement, indicating and recording for primary and secondary air?

ANSWER

An indication of primary air flow to each pulverizer is included, which will read out in kg/hr. Secondary air flow to each burner will be indicated by draught loss measurement across the perforated plate hood surrounding each register. A magnehelic gauge is provided for each burner's air hood.

QUESTION

7. During tests, how will the coal flow rate be measured so as to get an accurate Ca/S ratio?

ANSWER

The existing system can be calibrated by taking a heat balance on the boiler and back-calculating fuel flow once the fuel's heating value is

known. This is a cumbersome method which should produce satisfactory results. Ideally, gravimetric feeders should be used for this type of pulverizer.

A ratio controller will be provided to feed limestone at a rate which will vary with the boiler input to maintain the proper calcium to sulfur mole ratio. The plant's pneumatic controls use a 5-25 psi signal (according to heating plant personnel) into which an I/P or E/P converter can be installed to provide the proper control signal for the limestone feeder.

C. LIMESTONE SYSTEM

QUESTION

1. The position of the silo must be such as to allow access for vehicles to reach the ash hopper, stack and other equipment in the vicinity.

ANSWER

The position of the silo shown on the drawing is not fixed. It can be moved further from the building, within reason, without cost increase.

QUESTION

2. Should the outdoor location of the limestone silo cause problems due to moisture and low temperatures, what modifications are possible and at whose cost?

ANSWER

Havelock Lime Works was consulted on this matter. They said that moisture and low temperature presented no problems to their operation. Therefore, Foster Wheeler did not include a silo drier. However, a silo drier is now included due to the concern expressed. Foster Wheeler agrees that installing the drier should be good insurance against possible moisture related problems for a minimal expense.

QUESTION

3. The design limestone rate seems low. Please check.

ANSWER

Foster Wheeler has checked the design limestone feed rate and confirms that it is low. The engineer designing the limestone system based his calculations on Btu input stated on page 2 of the G. A. Robb Associates' report on the March 25-31, 1982 testing. The report states that "Each burner has a capacity of 35 million Btu per hour...". This is incorrect as the total unit output is 70 million Btu per hour. Therefore, Btu input per burner would have to be 70 x $10^6/2$, divided by the unit efficiency, which was assumed to be 82%. The design limestone feed rate has been increased accordingly.

QUESTION

4. On P20, para. 3, it is stated that the limestone injection pipes are adjustable during firing so that the direction of injection may be altered to achieve optimum performance. Will this be determined during commissioning and locked into position?

ANSWER

The limestone injection pipes will be adjusted to an optimum position during commissioning and then fixed in that position.

QUESTION

5. Is the boiler output signal to the limestone system included in the scope of supply?

ANSWER

No, the boiler output signal to the limestone system is not included in the scope of supply.

QUESTION

6. Is the "cheapest available sorbent" (P18) Havelock limestone or are other sources to be considered?

ANSWER

Havelock limestone is to be the test sorbent.

APPENDIX A - BURNER MANAGEMENT SYSTEM

EQUIPMENT LIST

The following is a list of the equipment to be supplied for the burner management system, with a brief description of each item:

Item	Qty.	Description
1	1	Master control room insert panel. This will be installed in the boiler control panel in an appropriate position, yet to be determined. It will contain backlighted push buttons for controlling all the system functions. The lights will indicate equipment status. There will be first out cause of trip indicators. This is a screen onto which the primary cause of a trip is projected. The panel is completely factory wired to plug-in connectors which mate with pre-fabricated cables.
2	1 set	Prefabricated cables to connect item 1 above to the Master logic cabinet. There are 4 cables of 50 conductors each. We have assumed a 50 ft. length for these cables. There is a price add/deduct for adjusting to the actual required length.
3	1	Master Logic Cabinet. This cabinet contains all necessary power supplies, mill logic controls, fuel safety interlocks, and first out light logic. It is completely factory wired and tested. The cabinet measures 90" high by 32" wide and 50" deep. It is constructed in accordance with NEMA 12 guidelines.
4	1 set	Pressure, differential pressure and temperature switches to provide the required inputs to the burner management system.

Item	Qty.	Description
5	2	Main coal flame detector, Forney Infrared Dynamic Detector (IDD-II), complete with mounting tube, 40 ft. of prefabricated cable, heat block manual ball valve and self-checking flame detector amplifier.
6	2	Ignitor oil flame detector. Description as per item 5.
7	2	Forney type QMAH mechanically atomized oil ignitors. Firing capacity of each to be 4 million Btu/hr firing No. 2 oil. Each ignitor includes a mounting tube, retraction assembly with limit switches, control solenoid, gun coupled limit switch, one flexible metal hose, one manual shutoff valve, high energy spark ignitor (HESI) and 15 ft. high voltage cable for HESI.
8	2	Ignitor oil shutoff valve. This is a 1/2" ball valve with actuator, limit switches and solenoid valve.
9	1	Ignitor oil trip valve. This is also a 1/2" ball valve, with operator, 2 limit switches and dual coil solenoid valves.
10	2	Ignitor purge valve. 1/2" ball valve with operator, limit switches and dual coil solenoid valve.
11	2	Primary air flow indications, each consisting of 1 pitot, 1 air flow transmitter, 2 low pressure capillary assemblies, and 1 meter to be installed in the master control room insert panel (item 1).
12	2	Burner shutoff damper. To be installed in the coal conduits downstream of the pulverizer exhauster fans. Complete with actuators, limit switches, couplings and adapters to mount to the conduits.

Burner Management System Operating Features

The burner management system is designed to help safely and efficiently operate the ignitors and coal burners while protecting the heating unit and its auxiliaries. It will enable primary air flow to be controlled to maximize flame stability and emissions control. Back lighted pushbuttons and status indicators provide procedural information to the operators as well as system status information. The first out lights indicate the problem initiating a fuel trip, enabling the quickest possible recovery.

Before the unit can be started, it must be purged of any possible accumulation of combustibles. The master control room insert panel will indicate when purge air flow is adequate. The purge start button is then pushed, starting the purge timing relay. No fires can be lit off until this step is completed. When the purge timer relay times out, the purge complete light goes on, allowing ignitors to be put into service by pushing a button. An indicator light goes on when a satisfactory ignitor flame is seen to tell the operator that the ignitor is in service.

Placing the pulverizers into service will also have safety interlocks. The burner management system will verify that the burner register is opened to the lightoff position, that the ignitor is in service, and that no trip conditions exist, such as high or low furnace pressure, combustion air flow low, etc. When safe conditions are verified, the permission to start pulverizer light will go on, and the coal fires can then be put into service.

The fires will be tripped out of service if a safety problem should arise. For example, if the unit's outlet stop/isolation value were to be closed accidentally, the pulverizers and ignotors would automatically trip to prevent damage to the unit. Complete burner management system logic schematics will be furnished when the detailed design of the system is undertaken.

The first out lights are an extremely valuable operating feature. It can be difficult to ascertain the cause of a fuel trip after it occurs. For example, if themain coal fires are tripped out of service, the furnace pressure can spike as a result of the collapsing flame. Examining the furnace pressure chart will show that the pressure spiked at the same time as the coal fires were lost, but there is no way of telling if the pressure spike caused the trip or was just a consequence of the trip. The first out indication will tell what problem occurred first to cause the trip, such as loss of a mill motor, low combustion air flow. or other cause.

Ignitors

The Forney oil ignitor recommended is smaller in size and capacity than the presently installed oil gun. It fires at a rate of 4 million Btu/hr. (108 litres per hr), while the old gun fired at a rate of 5.6 million Btu/hr (150 litres per hr) during the March, 1982 testing. We are assuming that this is about minimum load on the presently installed ignitor. This reduction in oil firing constitutes a 28% savings in fuel.

The Forney ignitor uses High Energy Spark Ignition (HESI) for ignit-

ing the oil flame. The HESI does not use spark rods, which frequently need adjustment. As the name implies, it provides a high energy electrical spark which gives positive ignition of the oil flame with excellent reliability.

These oil ignitors are remote controlled. They are put in or out of service with the push of a button.

Bibliography for Section 3.4

Attig, R. C. "Pilot Plant Investigation of the Potential of Direct Limestone-Dolomite Additive Injection for Control of Sulfur Dioxide from Combustion Flue Gases", Dist. by Clearinghouse, U.S. Dept. of Commerce, Nat. Bureau of Standards, Inst. for Applied Technology , December, 1968

Bituminous Coal Research, Inc. "Research on Methods for Control of Sulfur Dioxide Emissions from Coal Burning Power Boilers", BCR Report L-273 to Electric Research Council & National Coal Association, March 7, 1968.

Borgwardt, Robert H., "Kinetics of the Reaction of SO_2 with Calcined Limestone", Environmental Science & Technology, Vol. 4, No. 1, January 1970.

Case, Patricia, Energy and Environmental Resources Co., Irvine, Ca., Personal Interview, January 5, 1983

Christman, P. G., Edgar T. F., "Analysis of Limestone - Sulfur Interactions for Fluidized Bed Combustors", Dept. of Chemical Engineering, University of Texas.

Coutant, R. W., et al "Investigation of the Reactivity of Limestone and Dolomite for Capturing SO^2 from Flue Gas", Dist. by Clearinghouse, U.S. Dept. of Commerce, Nat. Bureau of Standards, Inst. for Applied Technology

Coutant, R. W., R. E. Barrett and E. H. Lougher, "SO_2 Pickup by Limestone and Dolomite Particles in Flue Gas", Journal of Engineering for Power, April 1970

Dreymal, Dennis, U. S. Environmental Protection Agency, Research Triangle Park, Durham, N. C. Personal Interview, January 5, 1983

Duwel, Ludwig, Karl-Wilhelm Buhne and Dr. Hans Lahann "Investigation of the Capture of Ash and Sulfur for Brown Coal Firing of Steam Generators", Braunkohle, n. 9, Sept. 1972, p. 297-310

Goldschmidt, K., "Experiments for Removal of Sulphur Dioxide from Flue Gases", Institut fur Verfahrenstechnik und Dampfkesselwesen der Universitat Stuttgart. 1967.

Hartman, Miloslav and Robert W. Coughlin, "Reaction of Sulfur Dioxide with Limestone and the Grain Model", AIChE Journal, Vol. 22, No. 3, May, 1976

Hartman, Miloslav, and Robert W. Coughlin, "Reaction of Sulfur Dioxide with Limestone and the Influence of Pore Structure", Ind. Eng. Chem., Process Des. Develop., Vol. 13, No. 3, 1974

Hubble, B. R., Stanley Siegel, L. H. Fuchs, H. R. Hoekstra, B. Tani and P. T. Cunningham, "The Formation of $Mg_3Ca(SO_4)_4$ during the Sulfation Reaction of Dolomite", Journal of the Air Pollution Control Association, Vol. 27, No. 4, April 1977.

Reid, William T. "Basic Factors in the Capture of Sulfur Dioxide by Limestone and Dolomite", Journal of Engineering for Power, January, 1970

Potter, Allen E., "Sulfur Oxide Capacity of Limestones", Ceramic Bulletin, Vol. 48, No. 9, 1969

Ramachandran, P. A. and J. M. Smith, "A Single-Pore Model for Gas-Solid Noncatalytic Reactions", AIChE Journal, Vol. 23, No. 3, May, 1977

Ruth, L. A. "Regenerable Sorbents for Fluidized Bed Combustion", Exxon Research and Engineering Company, Linden, N. J., Draft, 1977.

Schwartz, S. H. and R. N. Salzman, "Final Report. Experimental Investigation of the Penetration and Dispersion Phenomena in the Limestone Injection Method", Engineering Experiment Station, West Virginia University, Morgantown, West Virginia, April 1971.

Slack, A. V., H. L. Falkenberry "Sulfur-Dioxide Removal from Power Plant Stack Gas by Limestone Injection", Transactions of the ASME, January, 1970

Snyder, Robert B. and W. Ira Wilson, Irving Johnson, and Albert A. Jonke, "Synthetic SO_2 Sorbents for Fluidized-Bed Coal Combustors", Journal of the Air Pollution Control Association, Vol. 27, No. 10, October 1977

Sohn, H. Y. and K. Rajamani "Successive Gas-Solid Reactions in a Porous Pellet: Application to the Reaction of Metal Sulfides in the Presence of Lime", Chemical Engineering Science, Vol. 32, pp. 1093-1101, 1977

Stewart, Robert. Foster Wheeler Boiler Corp., Livingston, N.J., Personal Interview, January 4, 1983

Taylor, Thomas, Foster Wheeler Development Corporation, Livingston, N.J., Personal Interview, December 2, 1982.

Tennessee Valley Authority "Sulfur Oxide Removal from Power Plant Stack Gas", Muscle Shoals, Alabama, 1971.

Tennessee Valley Authority "Full-Scale Desulfurization of Stack Gas by Dry Limestone Injection", Vol. 1, Office of Research & Development, U.S. Environmental Protection Agency, Washington, D.C., August 1973, EPA-650/2-73-019-a

Tennessee Valley Authority "Sulfur Oxide Removal from Power Plant Stack Gas: Conceptual Design and Cost Study. Sorption by Limestone or Lime Dry Process", Dist. by Clearinghouse, U.S. Dept. of Commerce, Nat. Bureau of Standards, Inst. for Applied Technology, 1968.

Wen, C. Y. and M. Ishida, "Reaction Rate of Sulfur Dioxide with Particles Containing Calcium Oxide", Environmental Science & Technology, Vol. 7, No. 8, August 1973

Westinghouse R&D Center, "Experimental and Engineering Investigations for the Development of Fluidized Bed Combustion Processes", Pittsburgh, Pa.

Yang, Ralph T. , C. R. Krishna and M. Steinberg "Fluidized-Bed Coal Combustion with Lime Additives. The Phenomenon of Peaking of Sulfur Retention at a Certain Temperature", Ind. Eng. Chem., Fundam. Vol. 16, No. 4, 1977

Zentgraf, Karl-Martin "Supplement to the Contribution on SO_2 Measurements in Flue Gases and on Flue Gas Desulfurization with Compounds of Alkaline Earth Metals", Chemical Translation Service, Knoxville, Tenn. 1967

FOSTER WHEELER LIMITED

ST. CATHARINES, ONTARIO

APPENDIX C

STANDARD GENERAL TECHNICAL CONDITIONS

1. PROPOSAL: General Arrangement, principal dimensions and designs of the steam generator unit will be as shown on the proposal drawing identified on the Summary Performance Sheet herein. The principal features of the equipment are stated in general terms throughout the proposal and the specific details not fully described will conform to Foster Wheeler's Engineering Standard.

2. CODES: The equipment included in this proposal is designed and built in accordance with the applicable ASME Code and Foster Wheeler Standards in effect as of the date of this proposal excluding ecological requirements, other standards, rules, regulations and safety codes except where these are specifically defined herein. Should any changes be required in the equipment to meet subsequent code requirements or new provisions, the Purchaser shall inform Foster Wheeler of such changes and shall recognize resultant price and schedular adjustment for changes actually made to comply with such requirements.

3. PERMITS, LICENSES AND APPROVAL OF PLANS: Unless otherwise specifically provided herein, the Purchaser shall be responsible for all permits, licenses, approvals of plans or specifications required for installation at the job-site and for any required fees so incurred. If changes to the equipment covered by this proposal are required to meet the approval of any authorities having jurisdiction, the Purchaser shall inform Foster Wheeler of such changes and shall reimburse it and recognize schedular adjustment for changes made to so conform.

4. SAFETY REGULATIONS (EQUIPMENT/MATERIALS): All operations in the construction of the steam generator and accessory equipment supplied by Foster Wheeler will comply with all applicable governmental safety rules and regulations in effect as of the date of this proposal.

   Noise abatement equipment such as safety valve silencers, inlet sound trunks for fans and similar noise attentuation equipment which are specifically identified in this proposal, will be supplied by Foster Wheeler. However, Foster Wheeler assumes no responsibility for safety compliance regulations relative to noise levels. If any changes are required in the equipment covered by this proposal to meet safety regulations beyond the ASME Code or specifically agreed requirements identified herein, the Purchaser shall inform Foster Wheeler of such changes and shall reimburse it for changes made and recognize schedular adjustment. Foster Wheeler's obligation under this Provision shall terminate upon expiration of the Contract Warranty period.

   In no event shall Foster Wheeler be responsible for work and/or equipment furnished by others and becoming an integral part of the Power Plant which may in any manner contravene any applicable regulations. To this end, the Purchaser agrees to hold harmless Foster Wheeler from any and all liability.

5. ECOLOGICAL REGULATIONS: Emission guarantees if provided will be as defined under "Performance Guarantees" herein. Foster Wheeler's liability will be limited to that given under "Terms and Conditions of Sale", item 8 and any other limitations given within this proposal.

6. A. DRAWINGS: If a proposal drawing is furnished with this proposal, it shall be considered to illustrate the proposal (not to be used for construction purposes) and in case there is any discrepancy in detail between the proposal and the drawing, the proposal shall apply. In no case shall the proposal be construed to include equipment which the drawing clearly indicates shall not be furnished by Foster Wheeler and vice versa. In no case shall Foster Wheeler be called upon to furnish additional materials, equipment or an arrangement more costly than that set out in the contract document.

   B. The Purchaser shall promptly furnish Foster Wheeler in the English language, all information, instructions and drawings requisite to the execution of the order or contract. Foster Wheeler shall furnish the Purchaser with nomore than three sets (or one reproducible) unless otherwise specified, of the general arrangements or outline drawings for the equipment, as are necessary. These drawings shall be furnished promptly in accordance with Foster Wheeler schedule requirements. The Purchaser shall promptly return one (1) copy of these drawings marked with his approval. Approval delays can result in rescheduled and/or delayed fabrication and shipping dates; cost incurred by these delays and changes are for the Purchaser's account. After approval unless otherwise stated herein, Foster Wheeler will provide to Purchaser three prints (or one reproducible) of such final drawings and three sets of operating instructions.

   The costs incurred by Foster Wheeler due to changes in the drawings, making them non-conforming with the intent of the proposal or contracts, or changed from previous instructions by the Purchaser shall be for the Purchaser's account with corresponding schedular change.

7. FOUNDATIONS: Unless otherwise specified, Foster Wheeler shall provide the Purchaser with not more than three sets of drawings (or one (1) set of reproducibles) showing the equipment with reference to foundations, including loading diagrams and showing location of anchor bolts in the foundations. Foster Wheeler shall not be responsible for the depth of the footings, design, size or accuracy of the foundations or the character of the materials

INSPECTION, TEST AND WARRANTY CONDITIONS

1. ASME CODE:

a. Each steam generator will be built in accordance with ASME Boiler Code for the working pressure shown on Summary Performance pages herein. Foster Wheeler will furnish the Purchaser with a certificate from its authorized boiler inspection authority stating that the steam generator complies with the ASME Boiler Code for the stated design pressure. Foster Wheeler will pay for such shop inspection in all cases as well as field inspection where field construction is undertaken by Foster Wheeler. Field inspection by any insurance company shall be arranged for and paid for by the Purchaser, unless otherwise stated herein.

b. When field construction is sufficiently completed, the steam generator shall be tested at the ASME hydrostatic test pressure (one and one-half times design pressure) and made tight at design pressure by the construction contractor. The Purchaser shall provide water of the required quality and temperature for said test, introduce same into the boilers when they are ready for test, shall also provide drainage from blow-off and protection against freezing when test has been completed.

2. AIR TEST:

a. In the case of field erected pressurized units, the openings of the unit shall be blanked and air shall be admitted until the internal presure reaches 1-1/2 times the furnace design pressure but in no case shall the pressure exceed 20 inches W.G. The unit shall then be sealed and, if the pressure drop does not exceed 5.0 inches W.G. in ten minutes, the unit shall be considered acceptably tight.

b. Similarly, in the case of shop assembled boilers, the furnace and steam generator gas pass enclosure shall be blanked off and air admitted until the internal pressure reaches 1-1/2 times the expected furnace operating pressure, but in no case shall the pressure exceed 20 inches W.G. nor be less than 7 inches W.G. The unit will then be tested for leaks with a soap and water test around all weld areas.

3. PERFORMANCE TESTS:

a. The performance of the equipment covered in this proposal, as set forth on the summary performance pages herein, is predicted only. This and any other predicted performance data and/or curves covering alternate operating conditions are submitted for the Purchaser's convenience as a guide to probable performance results and are not to be construed as a contract obligation unless expressly stated otherwise in this proposal.
Performance tests, if required, and performance calculations shall be in accordance with the applicable Short Test Form in the latest edition of the ASME Test Code for stationary steam generating units and calculated by the heat loss method, and the measure of performance shall be the results of such test. Performance calculations shall be based on the steam tables in the latest edition of "Thermodynamic Properties of Steam" by Keenan and Keyes.

Testing shall be conducted under steady state conditions over the test period and an average of the results used to determine unit performance.

b. Performance tests, of the steam generator or any of the equipment furnished by Foster Wheeler, if required, shall be run within the time limit specified within this proposal, it being understood that Foster Wheeler may require preliminary tests. Tests shall be conducted only on one representative unit, mutually agreed upon by the Purchaser and Foster Wheeler. The Purchaser, at his own expense, shall make all preparations, calibrations, furnish all operating and testing personnel and incur all expenses connected with such tests, and shall give to Foster Wheeler at least fifteen days' notice of the date or dates on which tests will be conducted.

c. Foster Wheeler's representative shall have access to the records at all times, and the test shall be conducted in manner to satisfy Foster Wheeler that the specified performance conditions are being maintained. A complete copy of test data and results shall be furnished to Foster Wheeler.

d. The general arrangement of equipment furnished by Foster Wheeler, and the general design and arrangement of related equipment furnished by others, shall not be less favorable than indicated on the proposal drawing identified on the Summary Performance Sheet herein.

e. The equipment shall have been constructed in accordance with Foster Wheeler's plans and specifications, properly maintained and operated by the Purchaser, and shall be in operating condition satisfactory to Foster Wheeler. The heat absorbing surfaces shall be clean inside and out.

f. Any equipment not furnished by Foster Wheeler affecting the performance of the equipment furnished by Foster Wheeler shall be selected with mutually agreed characteristics and margins to meet the conditions of operation set forth in the Summary Performance page and means provided by the Purchaser to control the operating parameters over the entire operating range.

selected for such construction. Adequate foundations, having plan measurements in accordance with such drawings including foundation bolts and plates, ducts, concrete work and all grouting shall be furnished by the Purchaser. This shall include the incorporation by the Purchaser of items for inclusion in such foundations such as sleeves, door frames, damper frames, etc. Foster Wheeler shall not be responsible for any damages, or repairs necessary to the equipment furnished by it, caused by or resulting from defects in or settlement of the foundations. Foster Wheeler shall provide reasonable guidance toward the design of foundation for rotating equipment but shall not be responsible with regard to their adequacy or interaction with this equipment.

8. PREPARATION FOR SHIPMENT: Unless otherwise specified, shop surface preparation and painting of metal parts, where required, shall be to the manufacturer's standard and excludes any field painting. Additional provisions for shipment such as protective coatings for machined surfaces, temporary closures, weather protection etc. shall be to the manufacturer's standards unless otherwise specified herein.

9. MOTORS AND STARTERS: Motors and starters where specified hereinbefore to be furnished by Foster Wheeler shall have current characteristics as specified below and any motors being furnished by the Purchaser shall be assumed to be for those current characteristics. Controls, signal lights, etc. shall operate on the current characteristics noted below.
All electric motors unless otherwise specified hereinbefore, shall be constant speed squirrel cage induction motors with protected type frames for normal torque, normal starting current, standard temperature rise.

   All electric starters unless otherwise specified hereinbefore, 5 HP and over, shall be of the full voltage, across-the-line standard magnetic type with undervoltage and overload protection only. Where no instrument panel is included as part of this proposal, push buttons shall be mounted in the cover of the starter or adjacent to the starter. Where an instrument panel is included, all separate push buttons for magnetic starters shall be of the flush mounting type mounted thereon and equipped with back covers unless otherwise specified. Stop-start push buttons only shall be furnished unless otherwise specified, except that where stop-start type of controls are being furnished by Foster Wheeler "Hand-off-Automatic" buttons shall be furnished, mounted in the starter covers.

10. SETTING: If furnished by the Purchaser, the Purchaser shall build into the brickwork all necessary door frames, sleeves or other such equipment being furnished by Foster Wheeler. Refractory or masonary ash pit linings where required, unless expressly stipulated to the contrary, shall be furnished by the Purchaser.

11. Foster Wheeler assumes no responsibility for damage to boilers or other equipment furnished by it, resulting from improper operation or introduction of improper substances to the equipment.

12. BOILER RATING: Wherever "Continuous Operation" or words of like import appear in the specifications, or other documents, such wording shall not be deemed as a guarantee of unit availability.

13. The treatment of feedwater and the conditioning of boiler water are beyond the control of Foster Wheeler, therefore, Foster Wheeler shall not be held responsible for damage due to the presence of oil, grease, scale or deposits on the internal surfaces of the equipment or for damage resulting from foaming caused by chemical conditions of the water, or for damage resulting from corrosion or caustic embrittlement. Foster Wheeler shall not be responsible for carryover resulting from the presence of oil, grease, syndets, or other contaminating materials.

14. This offer is based on the following:

MOTOR CURRENT CHARACTERISTICS

phase	hertz	volts	up to	HP
phase	hertz	volts	up to	HP

CONTROL CURRENT CHARACTERISTICS

phase	hertz	volts	up to	HP

INSPECTION, TEST AND WARRANTY CONDITIONS

1. ASME CODE:

a. Each steam generator will be built in accordance with ASME Boiler Code for the working pressure shown on Summary Performance pages herein. Foster Wheeler will furnish the Purchaser with a certificate from its authorized boiler inspection authority stating that the steam generator complies with the ASME Boiler Code for the stated design pressure. Foster Wheeler will pay for such shop inspection in all cases as well as field inspection where field construction is undertaken by Foster Wheeler. Field inspection by any insurance company shall be arranged for and paid for by the Purchaser, unless otherwise stated herein.

b. When field construction is sufficiently completed, the steam generator shall be tested at the ASME hydrostatic test pressure (one and one-half times design pressure) and made tight at design pressure by the construction contractor. The Purchaser shall provide water of the required quality and temperature for said test, introduce same into the boilers when they are ready for test, shall also provide drainage from blow-off and protection against freezing when test has been completed.

2. AIR TEST:

a. In the case of field erected pressurized units, the openings of the unit shall be blanked and air shall be admitted until the internal presure reaches 1-1/2 times the furnace design pressure but in no case shall the pressure exceed 20 inches W.G. The unit shall then be sealed and, if the pressure drop does not exceed 5.0 inches W.G. in ten minutes, the unit shall be considered acceptably tight.

b. Similarly, in the case of shop assembled boilers, the furnace and steam generator gas pass enclosure shall be blanked off and air admitted until the internal pressure reaches 1-1/2 times the expected furnace operating pressure, but in no case shall the pressure exceed 20 inches W.G. nor be less than 7 inches W.G. The unit will then be tested for leaks with a soap and water test around all weld areas.

3. PERFORMANCE TESTS:

a. The performance of the equipment covered in this proposal, as set forth on the summary performance pages herein, is predicted only. This and any other predicted performance data and/or curves covering alternate operating conditions are submitted for the Purchaser's convenience as a guide to probable performance results and are not to be construed as a contract obligation unless expressly stated otherwise in this proposal.
Performance tests, if required, and performance calculations shall be in accordance with the applicable Short Test Form in the latest edition of the ASME Test Code for stationary steam generating units and calculated by the heat loss method, and the measure of performance shall be the results of such test. Performance calculations shall be based on the steam tables in the latest edition of "Thermodynamic Properties of Steam" by Keenan and Keyes.

Testing shall be conducted under steady state conditions over the test period and an average of the results used to determine unit performance.

b. Performance tests, of the steam generator or any of the equipment furnished by Foster Wheeler, if required, shall be run within the time limit specified within this proposal, it being understood that Foster Wheeler may require preliminary tests. Tests shall be conducted only on one representative unit, mutually agreed upon by the Purchaser and Foster Wheeler. The Purchaser, at his own expense, shall make all preparations, calibrations, furnish all operating and testing personnel and incur all expenses connected with such tests, and shall give to Foster Wheeler at least fifteen days' notice of the date or dates on which tests will be conducted.

c. Foster Wheeler's representative shall have access to the records at all times, and the test shall be conducted in manner to satisfy Foster Wheeler that the specified performance conditions are being maintained. A complete copy of test data and results shall be furnished to Foster Wheeler.

d. The general arrangement of equipment furnished by Foster Wheeler, and the general design and arrangement of related equipment furnished by others, shall not be less favorable than indicated on the proposal drawing identified on the Summary Performance Sheet herein.

e. The equipment shall have been constructed in accordance with Foster Wheeler's plans and specifications, properly maintained and operated by the Purchaser, and shall be in operating condition satisfactory to Foster Wheeler. The heat absorbing surfaces shall be clean inside and out.

f. Any equipment not furnished by Foster Wheeler affecting the performance of the equipment furnished by Foster Wheeler shall be selected with mutually agreed characteristics and margins to meet the conditions of operation set forth in the Summary Performance page and means provided by the Purchaser to control the operating parameters over the entire operating range.

g. The fuel characteristics shall not be less favourable than those indicated for the fuel or fuels listed in this proposal.

h. In cases when firing is by stokers, the means of delivering fuel to the stoker hopper or inlet shall be such as to prevent segregation of the fuel. Fuel sizing must be in accordance with Foster Wheeler's recommendations.

4. STEAM AND WATER PURITY TESTS

a. Samples of water for testing shall be taken from the continuous blowdown, or from a suitably located sampling pipe, through a cooling coil to prevent flashing. Sampling and determination of boiler water conditions shall be under the methods contained in ASTM Special Technical Publication No. 148.

b. The maximum concentration of constituents in the boiler water shall not exceed those given in the following table for the applicable operating pressure:

Pressure at Outlet of Steam Drum psig	Total Solids ppm	Total Alkalinity ppm	Suspended Solids ppm
0-300	3500	700	300
301-450	3000	600	250
451-600	2500	500	150
601-750	2000	400	100
751-900	1500	300	60
901-1000	1250	250	40
1001-1500	1000	200	20
1501-2000	750	150	10
2001-and higher	500	100	5

c. Samples of condensed steam for determination of solids shall be obtained in accordance with the method specified in the latest edition of ASTM-D-1066, Tentative Method for Sampling Steam.

d. Solids in the steam samples may be determined by either of the three methods described below:

1. If the electrical conductivity determination of impurities in the condensed steam is used, it shall be made in accordance with the latest edition of ASTM-D-1125 Standard Method of Test for Electrical Conductivity of Water. Remove dissolved gases from the sample as completely as possible by mechanical means without contaminating the sample with any added material which will increase its conductivity. The conductivity shall be corrected to compensate for residual ammonia, carbon dioxide or other gases remaining in the sample and the dissolved solids shall be calculated from this corrected conductivity. For measuring performance by the electrical conductivity method, the average of ten determinations made at regular intervals throughout the test period shall be used.

2. If the gravimetric determination of impurities in the condensed steam is used, it may be made in accordance with Method A of the latest edition of ASTM-D-1069, Tests for Suspended and Dissolved Solids in Industrial Waters, or a similar method embodying the essential principles of that specification. For measuring performance by the gravimetric method the results shall be expressed as the average of three determinations made upon a composite sample which shall be taken throughout the entire test period.

3. If the sodium tracer determination of impurities in the condensed steam is used, it shall be made in accordance with the latest edition of ASTM-D-1428. "Tests for Sodium and Potassium in Water and Water formed Deposits by Flame Photometry." The sodium tracer method utilizes the element sodium as a tracer material to determine the amount of impurities in steam. It is assumed that the ratio of concentrations of sodium-to-impurities in steam is equal to corresponding ratio in boiler water.
Sodium concentrations in steam can be taken from a continuously flowing sample from at least ten separately collected samples taken under steady-state conditions at regular intervals during the test period.

APPENDIX C COMMERCIAL EXCEPTIONS AND COMMENTS

General Conditions - Form 1026 (S-100A)

Add the following sections to the General Conditions:

Section 30, Limitation of Liability: Contractor and its subcontractors or vendors shall not be liable to Her Majesty under this contract or in tort for loss of anticipated profits or revenue, loss of use, non-operation or increased expense of operation of other equipment, cost of capital, cost of purchased or replacement power or temporary alternate equipment, damage to the environment or other damage of a like nature, arising out of the performance, purported performance or non-performance by Contractor carrying out its obligation and work under this contract.

The liability of the Contractor and its subcontractors or vendors arising under the performance of this Contract, whether in contract, tort, warranty, strict liability, or otherwise, shall not exceed the purchase price paid on the Contract.

Page 47a Deleted

GENERAL CONDITIONS FOR FIELD CONSTRUCTION

These conditions are intended to supplement, conditions for supply of equipment and shall be read in conjunction therewith as well as the accompanying Price Schedule.

1. TAXES: Where pricing indicates that construction will be fully undertaken by Foster Wheeler, the price for construction shall include, unless indicated otherwise, any applicable Federal and Provincial sales taxes applicable to Foster Wheeler construction tools or incidental or temporary construction materials that are not part of the installed equipment.

2. INSURANCE: Unless indicated to the contrary on the Price Schedule:
A. The Purchaser shall provide and maintain "Builder's All Risk" insurance in the names of the Purchaser and Foster Wheeler including Foster Wheeler's subcontractors covering all materials, equipment, machinery, supplies and labour of any nature whatsoever supplied by Foster Wheeler which are to become a permanent part of the plant, while in transit, while awaiting construction, during construction and until all obligations of Foster Wheeler hereunder have terminated, against physical loss or damage from any cause whatsoever, except those risks normally excluded from such policies. Foster Wheeler shall be furnished a copy of the policy providing the above coverage prior to beginning of any field work.

B. Foster Wheeler agrees to take and provide all reasonable precautions, safeguards and protection against the occurrence of accidental injuries and damages to any person or property during the progress of the work and to be responsible for and indemnify and save Purchaser harmless from public liability and costs resulting from the sole negligent acts or omissions of Foster Wheeler, its employees, agents, or subcontractors.

C. Foster Wheeler shall procure and upon request shall submit to the Purchaser certificates evidencing Workmen's Compensation coverage for all its employees in accordance with the laws of the province in which any work is done.

D. Purchaser shall pay for and arrange for (if required) inspection by an Insurance Company on its premises.

3. PERMITS AND LICENSES: The Purchaser shall supply and pay for all permits, licenses, and special regulatory requirements of Governmental bodies (Federal, Provincial or Municipal) other than those specifically recognized as included by Foster Wheeler.

4. CONSTRUCTION SITE AND WORK CONDITIONS: Unless otherwise stated in the text of this proposal:

A. The Purchaser shall provide temporary enclosures (other than site office, tool or change rooms which are included in price herein) as may be required for field construction purposes heated to 70 ^{o}F and adequately lighted. These items shall be available in time to permit normal construction operations and reasonably comfortable working conditions and be adequate for construction needs.

Prior to start of Foster Wheeler's field work, Purchaser shall have foundations, catwalks, platforms and stairways fully ready for the installation of the equipment and building steel suitably torqued, where applicable. Where such foundations are incorrect any corrective work shall be by the Purchaser and stand-by costs or added expense of Foster Wheeler shall be for the Purchaser's account and time of completion adjusted accordingly.

If the Purchaser furnishes supporting steel platforms and gratings, these shall be in place prior to the start of work, if required by Foster Wheeler.

GENERAL CONDITIONS FOR FIELD CONSTRUCTION Cont'd/

B. The Purchaser shall provide railway siding with a level, drained, properly stabilized, and otherwise suitable space acceptable to Foster Wheeler within 200 ft. of and with free, direct and unobstructed access including a railroad spur to the site of construction, including any necessary right-of-way, access routes (suitable to support transport equipment with loads), together with such openings in structural steel, walls, pavements, floors, or roofs as may be required for all construction of the equipment. Removal of and replacement of such items to provide necessary access will be by the Purchaser in such manner as not to interfere with scheduled progress. If the basement floor is below grate, the Purchaser shall provide drainage of basement and a trestle acceptable to Foster Wheeler to move equipment and materials into the unit. These storage and construction areas shall be able to support cranes, trucks or other construction loads.

C. The Purchaser shall furnish security for the construction and material storage areas by means of suitable fencing or guard services.

D. In the event that Foster Wheeler's construction work is completed to the point of turnover and the Purchaser delays the date that the equipment is to be placed in operation, the Purchaser shall be responsible for preservation and maintenance of the equipment.

E. This proposal makes no provision for modification of the Purchaser's existing facilities beyond the scope of this proposal. If such modifications are necessary for the prosecution of Foster Wheeler's work, they shall be made by the Purchaser at its cost.

F. This proposal is based on the construction work being performed in accordance with the working arrangements, allowances and conditions established by Foster Wheeler's current agreement with field Trade Unions. In the event that the Purchaser, with respect to its own labour of other contractors, permits or condones relaxed working standards, labour practices or usages which are more liberal than those permitted by Foster Wheeler and Foster Wheeler is required to follow such relaxed standards, labour practices or usages, then the Purchaser shall reimburse Foster Wheeler for thereby any increased costs caused therby.

Any need to work non-standard hours, pay increased site allowances (board, commuting, etc.), use incentive arrangements, or use crews from remote Union locals, shall be reviewed with the Purchaser with such added costs being for the account of the Purchaser.

The working days and hours shall conform to local union agreements on a regular hour basis. Any overtime or shift work, except where undertaken at Foster Wheeler's sole option, shall be on Purchaser's written request with cost of overtime premium paid shift differential, related payroll burden and overhead and non-productive manhours associated with such overtime, multiple or shift work to be reimbursed to Foster Wheeler by the Purchaser.

G. The Purchaser shall furnish within 50 feet of the periphery of the work area, fuel, potable water, steam, compressed air, minimum of 300 cfm at 100 psig, and 220/440 volt, 60 cycle electric power as required for unloading, hauling, constructing the equipment together with all supervision, labour, fuel, and required for testing, drying out, and starting up the equipment. Fully adequate toilet facilities for construction personnel shall be supplied and maintained by the Purchaser convenient to the work area. All construction utilities and services shall be supplied by the Purchaser at no cost to Foster Wheeler and shall be available when Foster Wheeler commences work.

GENERAL CONDITIONS FOR FIELD CONSTRUCTION Cont'd/

H. The Purchaser shall control and co-ordinate the work of all Contractors on the site, so as not to cause delay to Foster Wheeler. Unless otherwise expressly stipulated in this proposal, it shall be understood that construction of all units and accessories can proceed simultaneously at the discretion of Foster Wheeler from the time Purchaser indicates that construction may start. Should Foster Wheeler's superintendent or crew become involved in stand-by time due to non-availability of all required site provisions, delays by interference of other trades or other conditions beyond the control of Foster Wheeler such as strikes, work stoppages, etc., or where construction must be consecutive or at separate times, then all resultant additional costs shall be for the account of the Purchaser and the time of completion extended accordingly.

I. Where weather conditions require, the building for installation shall be fully enclosed, heated to 65 °F and adequately lighted. Otherwise and for outdoor installations it shall be understood that pricing is based on weather permitting continuous operations.

Should construction be delayed or interrupted due to unfavourable weather, the time of completion shall be adjusted and the Purchaser shall reimburse Foster Wheeler for all resultant additional costs.

J. Foster Wheeler will supply such safety devices as are normally standard and are specifically defined herein as well, but none other. In the event further safety devices are required by the Purchaser to meet his applicable codes or standards, Foster Wheeler will, at the Purchaser's written request and at the Purchaser's expense, furnish the same after receipt of the detailed specification therefore. Foster Wheeler will exercise usual and ordinary case in the performance of construction on Purchaser's premises. This anticipates that the work force may smoke at the locale of construction and that there is no risk of fire or explosion due to hazardous conditions on the Purchaser's premises. Determination of such risks shall be the Purchaser's responsibility and he shall provide all necessary fire fighting devices, shielding and fire watch. If the Purchaser requires that Foster Wheeler construct the equipment during hazardous conditions, the Purchaser shall indemnify and hold harmless Foster Wheeler or his representatives, agents or employees or sub-contractors against all claims for loss or personal injury or property damage or resultant liability arising out of the performance of the work.

SUPPLEMENTARY GENERAL CONDITIONS

The Standard General Technical Conditions and Terms and Conditions of Sale as defined in this proposal are hereby amended by these supplemental conditions which will take precedence in each case:

This Quotation is based on carrying out only the work detailed above and is subject to adjustment by Change Order for additional work that becomes apparent during the execution of the contract.

Please note that this offer assumes the Purchaser shall carry direct damage insurance coverage unless his order directs Foster Wheeler to so arrange with premium added to reimbursable costs hereinbefore.

Customer will provide compressed air at 100 psi., 550 volt electrical power, change room and sanitary facilities.

Additional work beyond the scope detailed above will be carried out on a cost plus basis per form CD-21G

Not included in construction package is any and all civil works including foundations and structural changes as required to support the equipment installed.

This proposal is based upon the premise that all operations hereunder exclude the use of any asbestos containing products and is based on working in an asbestos free environment. Should any such condition arise and Purchaser is not prepared or able to arrange alternate materials or procedures to avoid any such exposure, then Foster Wheeler is prepared to review with the Purchaser procedures for continuing its work to minimize health risks with all added costs for the Purchaser's account and the Purchaser thereby indemnifying and holding harmless Foster Wheeler for all risks, injury or claims of any parties so resulting.

FOSTER WHEELER LIMITED

ST. CATHARINES, ONTARIO

GENERAL CONDITIONS FOR SUPERVISORY SERVICES

These conditions are intended to supplement the Terms and Conditions of Sale, whenever equipment offered includes, supervision for installation or start-up services and shall be read in conjunction therewith as well as the accompanying Price Schedule.

1. Where a Construction Superintendent(s) is offered to assist the Purchaser in the construction of the equipment, such superintendent(s) will act as a consultant or an advisor in the interpretation of drawings and specifications, will make recommendations, when requested, on methods of installation of the equipment. He will not be responsible for the procurement and direction of labour or quality of mechanical work performed by others. Purchaser shall provide at least 14 days notice in writing of the date Foster Wheeler's representative is required at the job site.

2. Where a Service Engineer(s) is offered, it shall be recognized that such Foster Wheeler representatives will be for the purpose of advising and consulting with the Purchaser or his representatives in the boiling out, starting up or operation of the equipment. Representatives of Foster Wheeler shall not be deemed licensed to operate the equipment and shall not be expected to take the place of operators. Purchaser shall provide at least 14 days notice in writing of the date Foster Wheeler's representative is required at the job site.

3. Foster Wheeler does not represent that its Construction representative is qualified to supervise the installation of brickwork, refractory setting or specialty equipment, but if required by a suitable notice in writing, Foster Wheeler shall arrange the services of such superindent(s) who shall act as consultants and advisors in the installation of such unit components. Charges for such personnel of Vendors to Foster Wheeler shall be charged at actual Vendors' billing to Foster Wheeler plus a 10% handling fee.

4. The Price Schedule shall identify the number of days, if any, each such representative shall be provided within the price set forth. This shall refer to the days out of Foster Wheeler's representative's home office (usually St. Catharines, Ontario) and includes travel time to and from the site as well as time at the site. Any additional time over such identified periods shall be reimbursable on a per diem basis, unless such time is undertaken at Foster Wheeler's option to carry out corrective work.

5. For any additional services of each Superintendent and/or Service Engineer as defined under Item 4 above, the Purchaser will pay to Foster Wheeler a per diem rate per working day and hourly rates for overtime in effect when service is rendered. It shall be noted that dates set forth represent regular Foster Wheeler working days in accordance with its union hours, so that any overtime hours at any time will be reimbursable under this clause. Similarly price quoted is based on service being rendered on a continuous basis in a single trip to the site and the cost of any additional trips shall be for the Purchaser's account. Travelling and living expenses, except for the identified period in the Price Schedule shall be reimbursed to Foster Wheeler in addition to the per diem rates.

6. The Purchaser shall furnish suitable heated office space, office equipment and parking space as may be required by Foster Wheeler's construction or service representative.

7. Except as defined below any supervision, service or inspection by Foster Wheeler Vendor's personnel of equipment, included in Foster Wheeler's scope of supply but manufactured by others, shall be to the account of the Purchaser.

8. Should additional technical personnel such as welding, quality control, x-ray specialists be required by the Purchaser, such can be made available on a per diem basis.

9. Foster Wheeler shall not be responsible for injury to persons or damage to property during the construction and/or operation of equipment and the Purchaser shall indemnify and save harmless Foster Wheeler against any loss, personal injury (including death) or damage resulting from the construction or operation of equipment. Foster Wheeler shall provide Workmen's Compensation Insurance and Public Liability and Property Damage Insurance with limits of $1,000,000.00 inclusive on his own employees only and such coverage shall be the extent of Foster Wheeler's liability hereunder, whether such liability is based on contract, negligence or otherwise. In no event shall Foster Wheeler or its subcontractors be liable for any special, indirect, incidental or consequential damages, such as, but not limited to, loss of anticipated profits or revenue, loss of use of power system, non-operation or increased expense of operation of other equipment, cost of capital, cost of purchased or replacement power, or claims of customers of Purchaser for service interruptions, or for any expense not specifically enumerated in this contract, whether or not such damages or expenses are alleged to be due, in whole or in part, to negligence attributable to Foster Wheeler or its subcontractors. The remedies of the Purchaser set forth in this contract are exclusive.

10. Payment for additional services or expenses as provided for herein shall be made upon presentation of invoices.

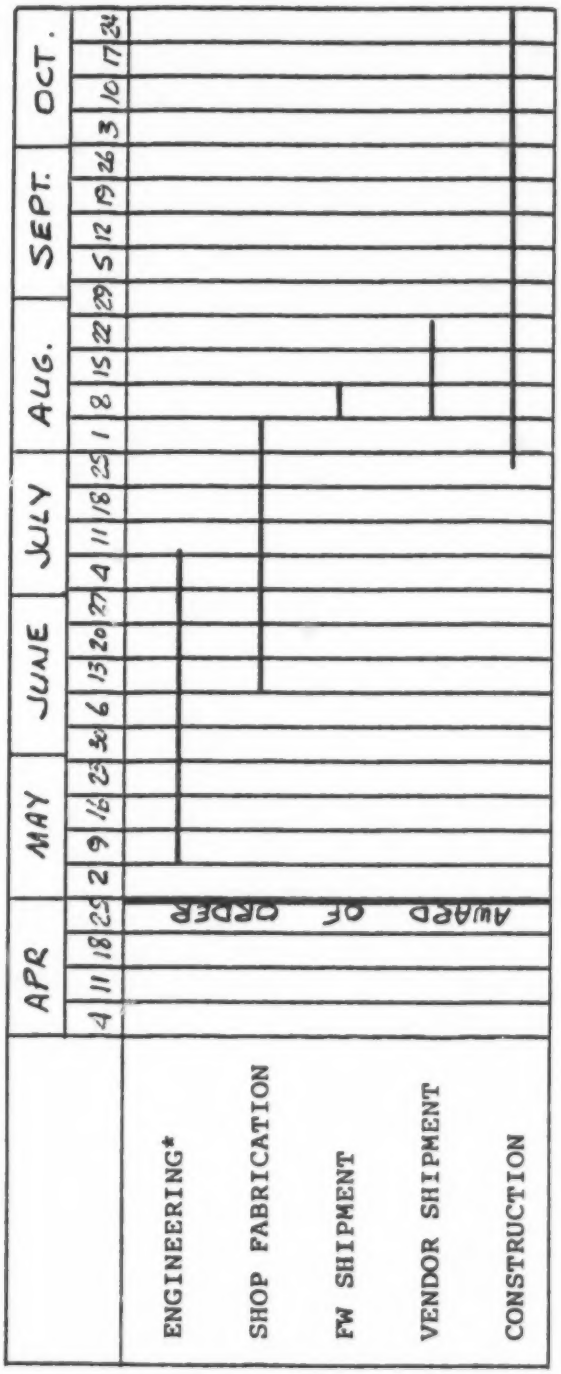
Vendor Services included

(i) FWEC 40 - working days.
(ii) Ducon 10 - working days.
(iii) Forney 25 - working days.
(iv)

Foster Wheeler

PROPOSAL NO. 2-51-2793 DATE:

ESTIMATED SCHEDULE



FOSTER WHEELER LIMITED

BUDGET PRICE SCHEDULE

Subject to the provisions as set forth herein, the equipment and/or services detailed in this Proposal are offered on the following basis:

Budget Price:	See Schedule on Page 36.
F.O.B. Point:	Gagetown, New Brunswick
Tax Basis:	Federal tax is excluded Provincial or Municipal Tax is excluded.

All pricing given herein is based on the schedule as outlined within the Proposal.

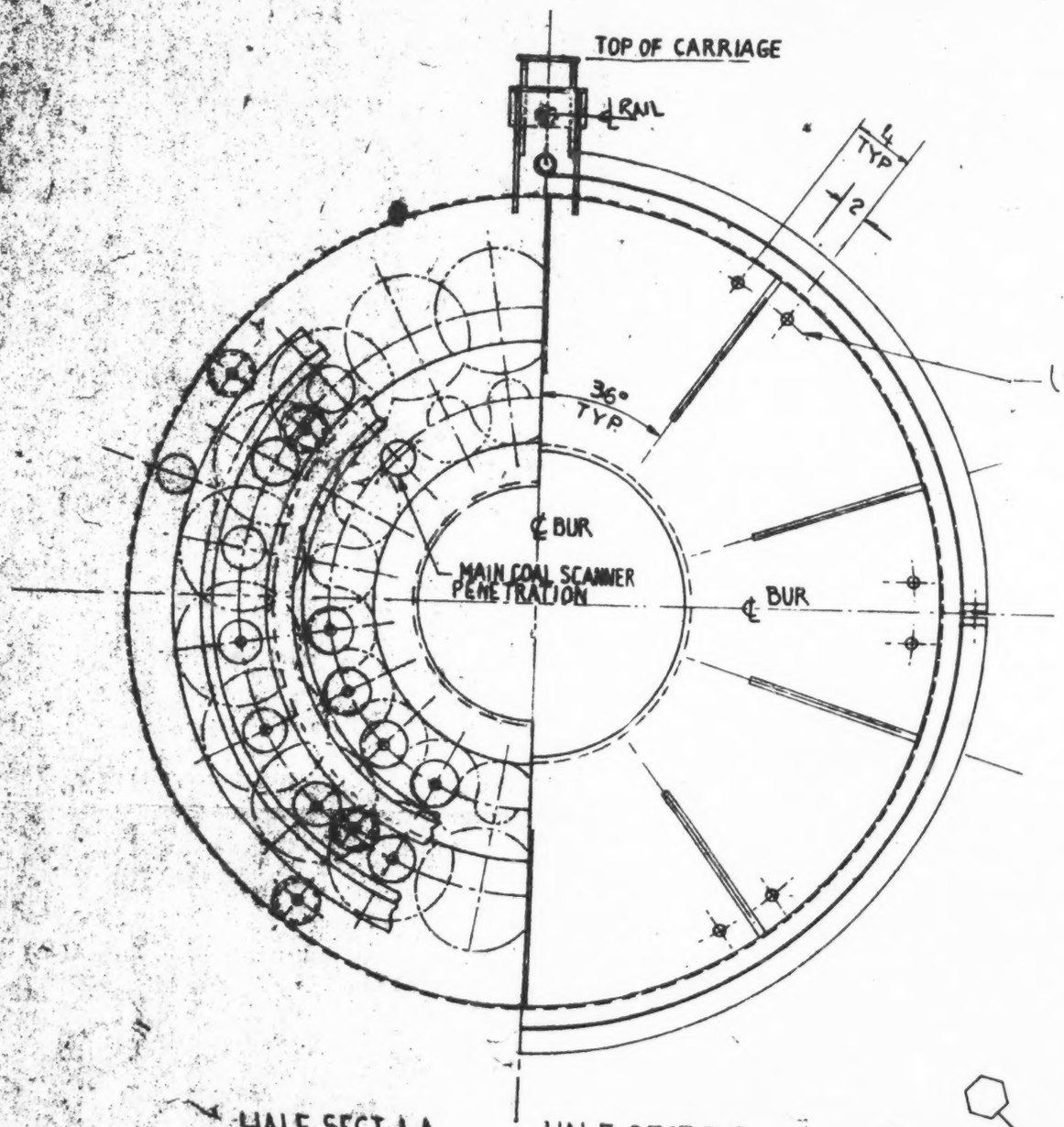
Supervision Services: (a) Construction included in installation price

(b) Service included as noted in conditions for supervisory service.

This proposal does not constitute an offer to sell. Any acceptance of this proposal is limited to the subject matter herein.

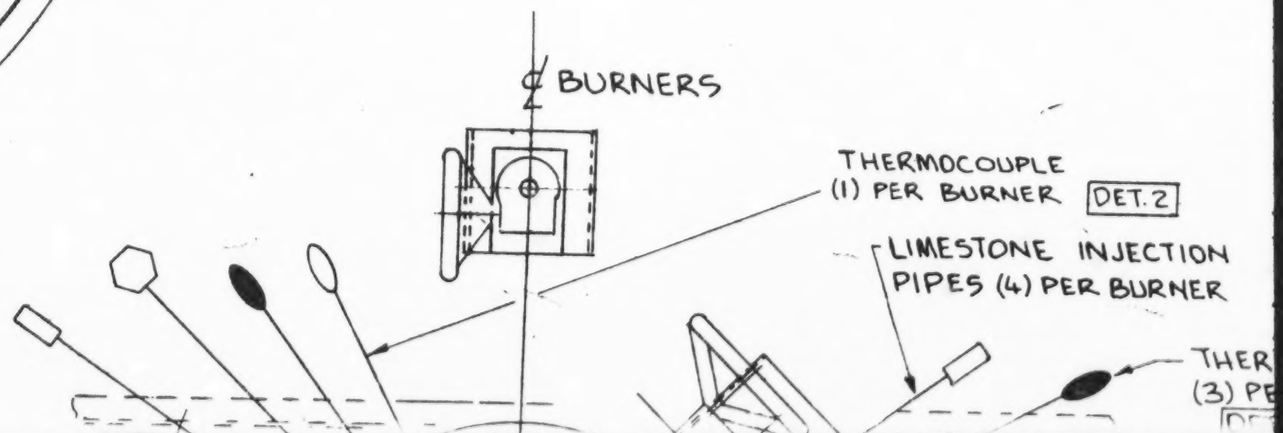
Submitted - Foster Wheeler Limited

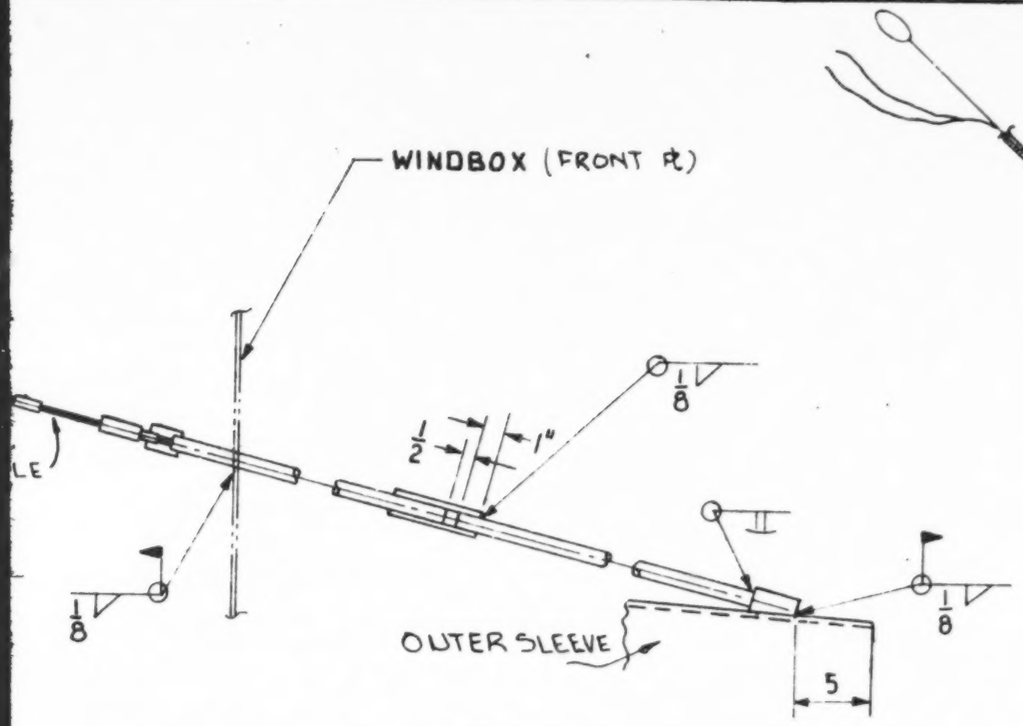
By



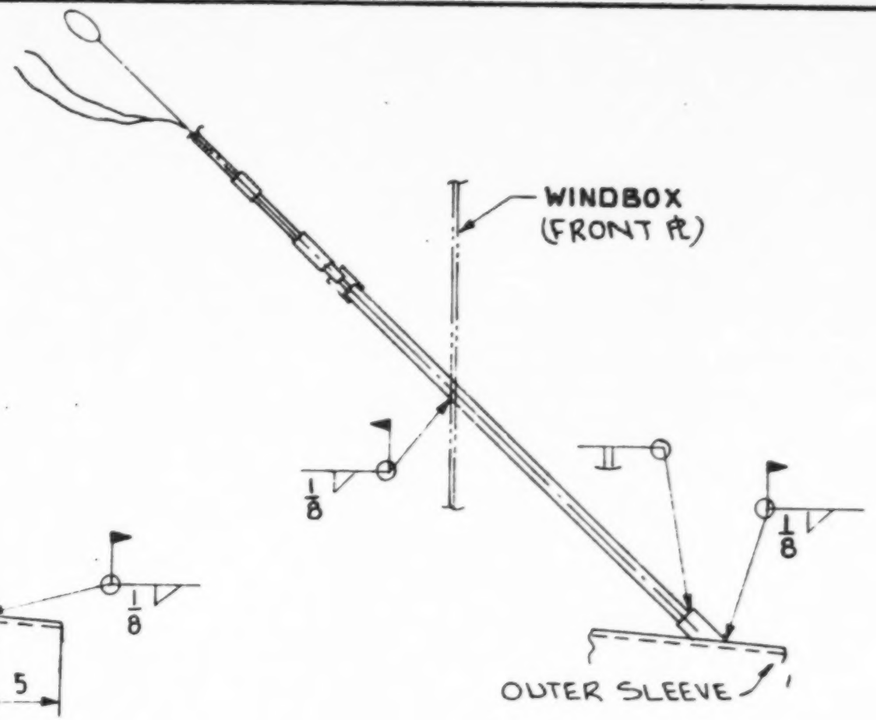
HALF SECT A-A

HALF SECT B-B

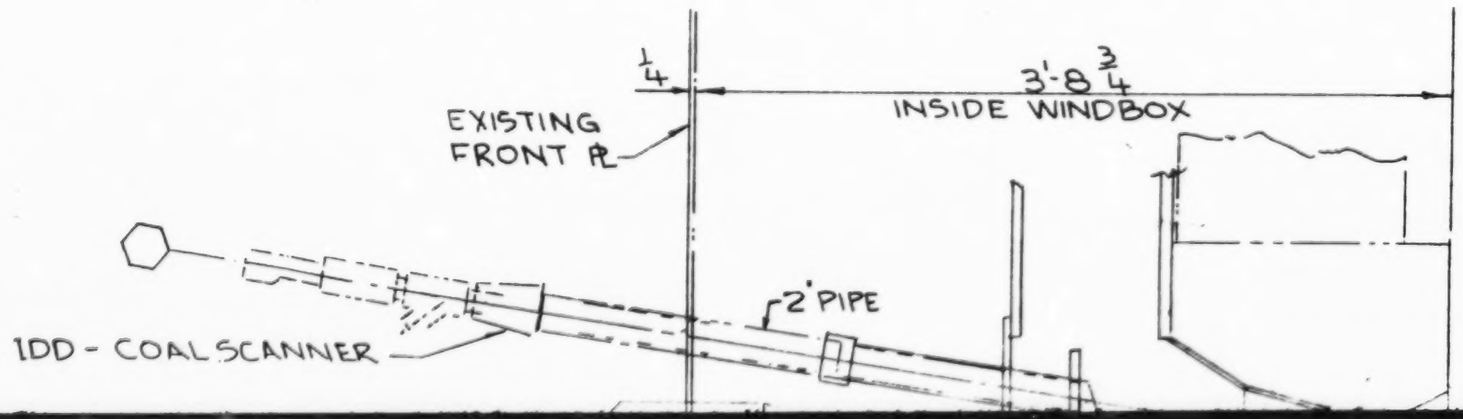




DETAIL-1



DETAIL-2



RMOCOUPLES
PER BURNER
ET-1

1. DO
FIG

2. AB
ARE
STA
DRA

N

GENERAL NOTES

1. DO NOT SCALE THIS DRAWING. USE FIGURE DIMENSIONS ONLY.

2. ABBREVIATIONS USED ON THIS DRAWING ARE IN ACCORDANCE WITH AMERICAN STANDARD "ABBREVIATIONS FOR USE ON DRAWINGS".

℄ LIMESTONE SILO

2'-6

0"

2'-6

3'-0

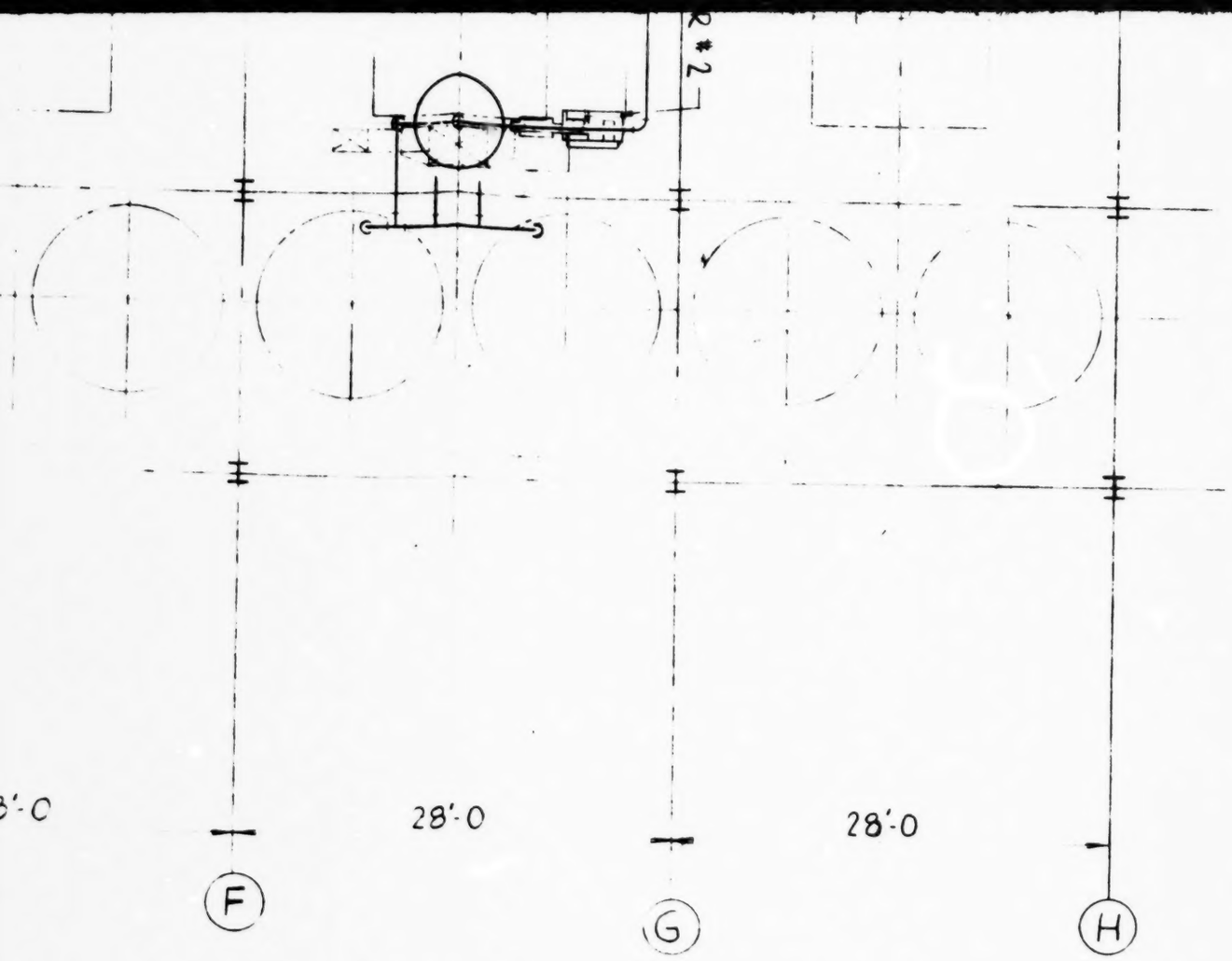
BLOWER #1

BLOWER #2

8'-6

4" SCH40

℄ LIMESTONE SILO


R # 2
28'-0
28'-0
F
G
H

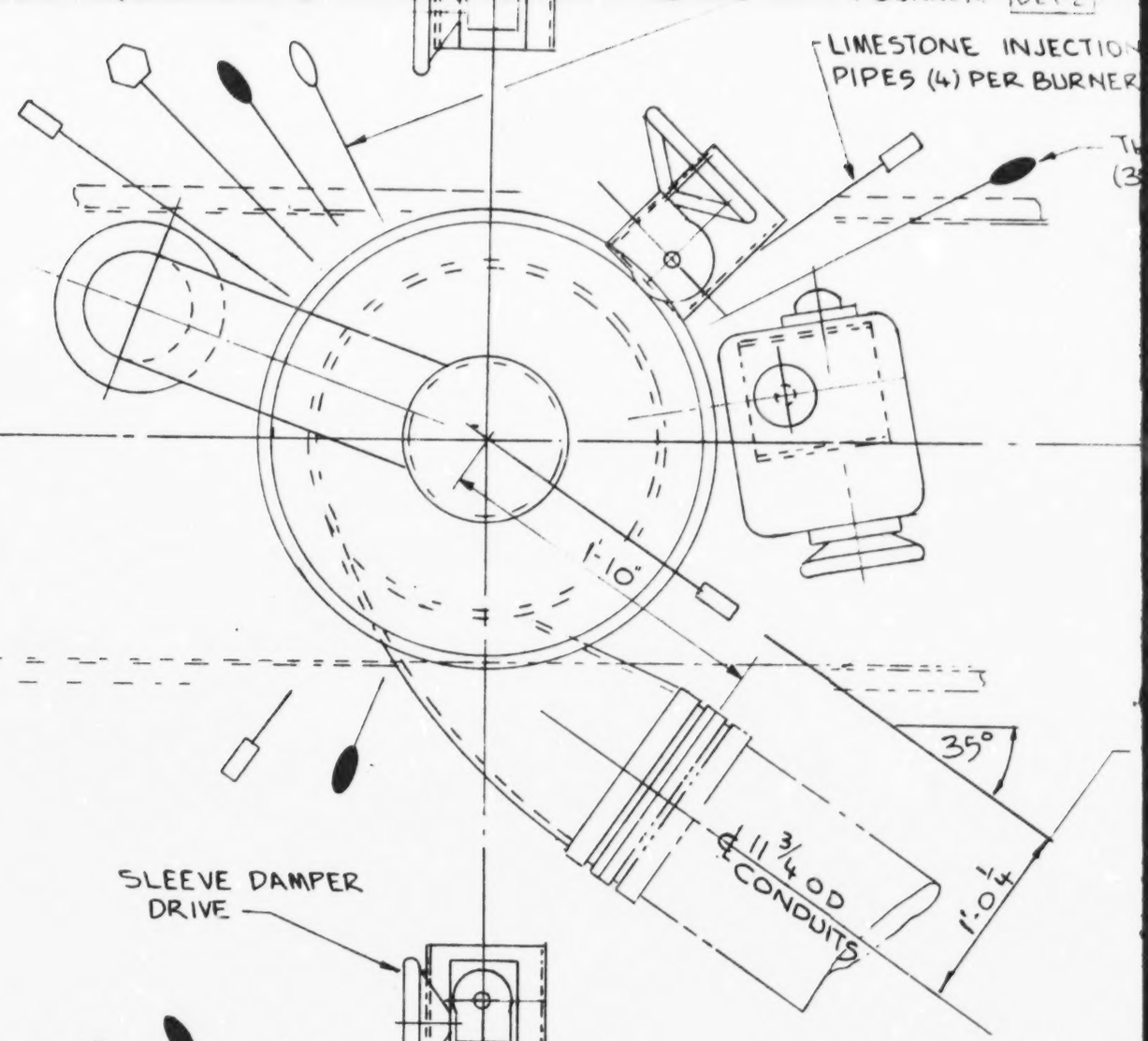
NOTES:

1. DO NOT SCALE THIS [illegible]
   FIGURE DIMENSIONS ONLY.

2. ABBREVIATIONS USED [illegible]
   ARE IN ACCORDANCE [illegible]
   STANDARD "ABBREVIATIONS FOR
   DRAWINGS".

HALF SECT A-A

HALF SECT B-B



5'-4

HERMOCOUPLES
3) PER BURNER
DET-1

MENSION MATCHES
XISTING CONDUITS

FRONT ℄

1DD - COAL SCANNER

2" PIPE

NEW FRONT ℄
AT BURNER AREA

℄ BURNER

THROAT DIA (NEW)

THROAT DIA (EXISTING)

NEW PROFILE

EXISTING PROFILE

SLEEVE DAMPER — CLOSED / OPEN

A

B

1'-1½

3

¼ ℄ (EXISTING)

RAIL

1½ϕ TUBES (EXISTING)

BRICK

6" TERTIARY AIR (HOT)

2'-4" IN

REGISTER DRIVE

IGNITOR & OIL GUN ASSY

INNER SLEEVE

℄ BURNER

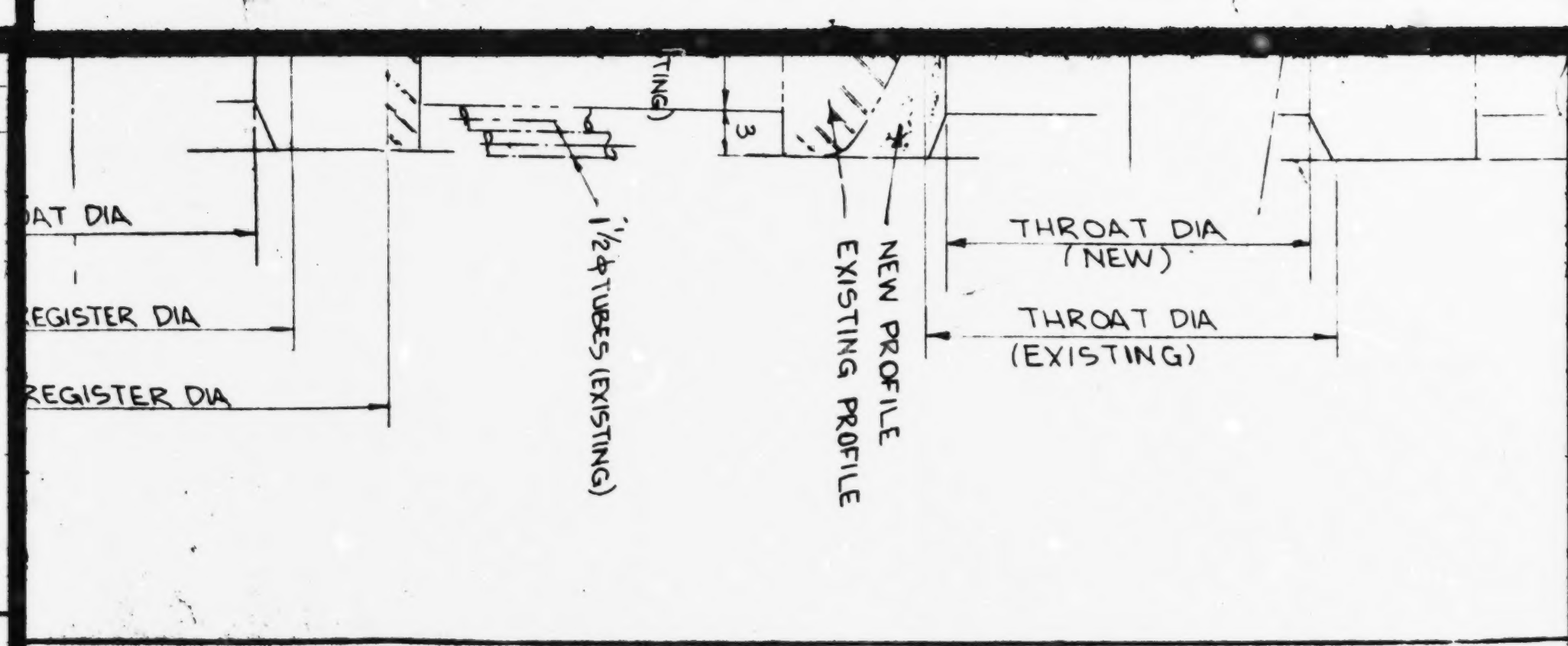
ADJUSTABLE TIP

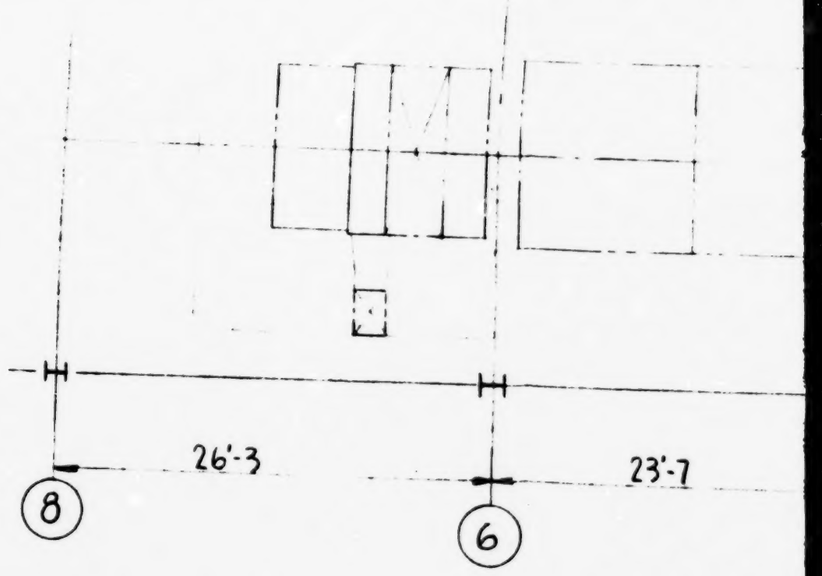
TRAVEL

DIA

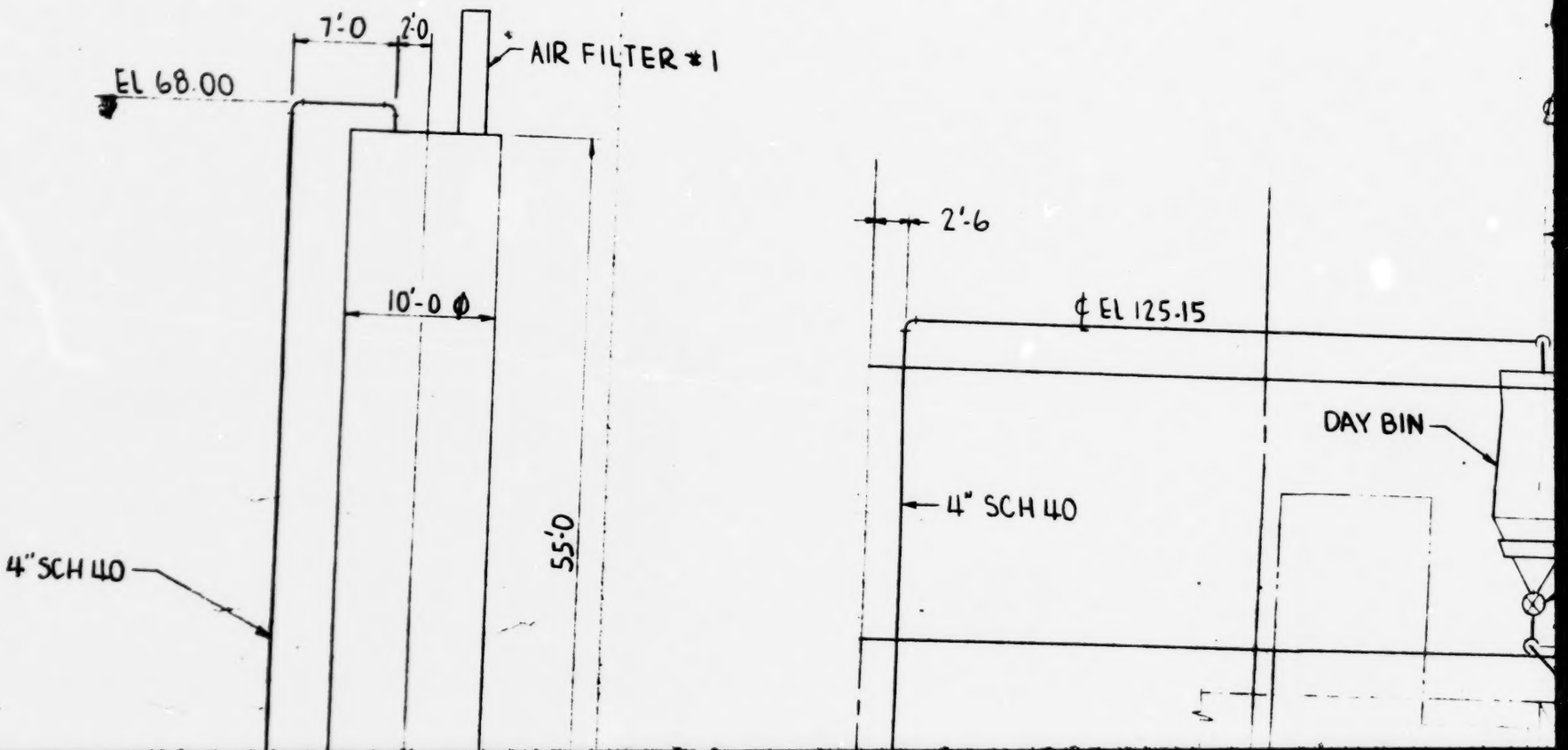
ER DIA

TER DIA


TING)
3
1½ ϕ TUBES (EXISTING)
EXISTING PROFILE
NEW PROFILE
THROAT DIA
(NEW)
THROAT DIA
(EXISTING)
AT DIA
EGISTER DIA
REGISTER DIA


26'-3
23'-7
8
6

PLAN VIEW


7'-0
2'-0
AIR FILTER #1
EL 68.00
10'-0 ϕ
55'-0
4" SCH 40
2'-6
℄ EL 125.15
DAY BIN
4" SCH 40

28'-0

1 (E)

23'-7 | 18'-0

(5) (3)

℄ DAY BIN "A"

4'-9

AIR FILTER #2

EL 124.88

BIN ACTIVATOR

ROTARY AIRLOCK #2

EL 106.69

45°

℄ DAY BIN

14'-0 | 14'-0

1'-0

10'-0

6'-0 ϕ

5'-0

EL 124.88

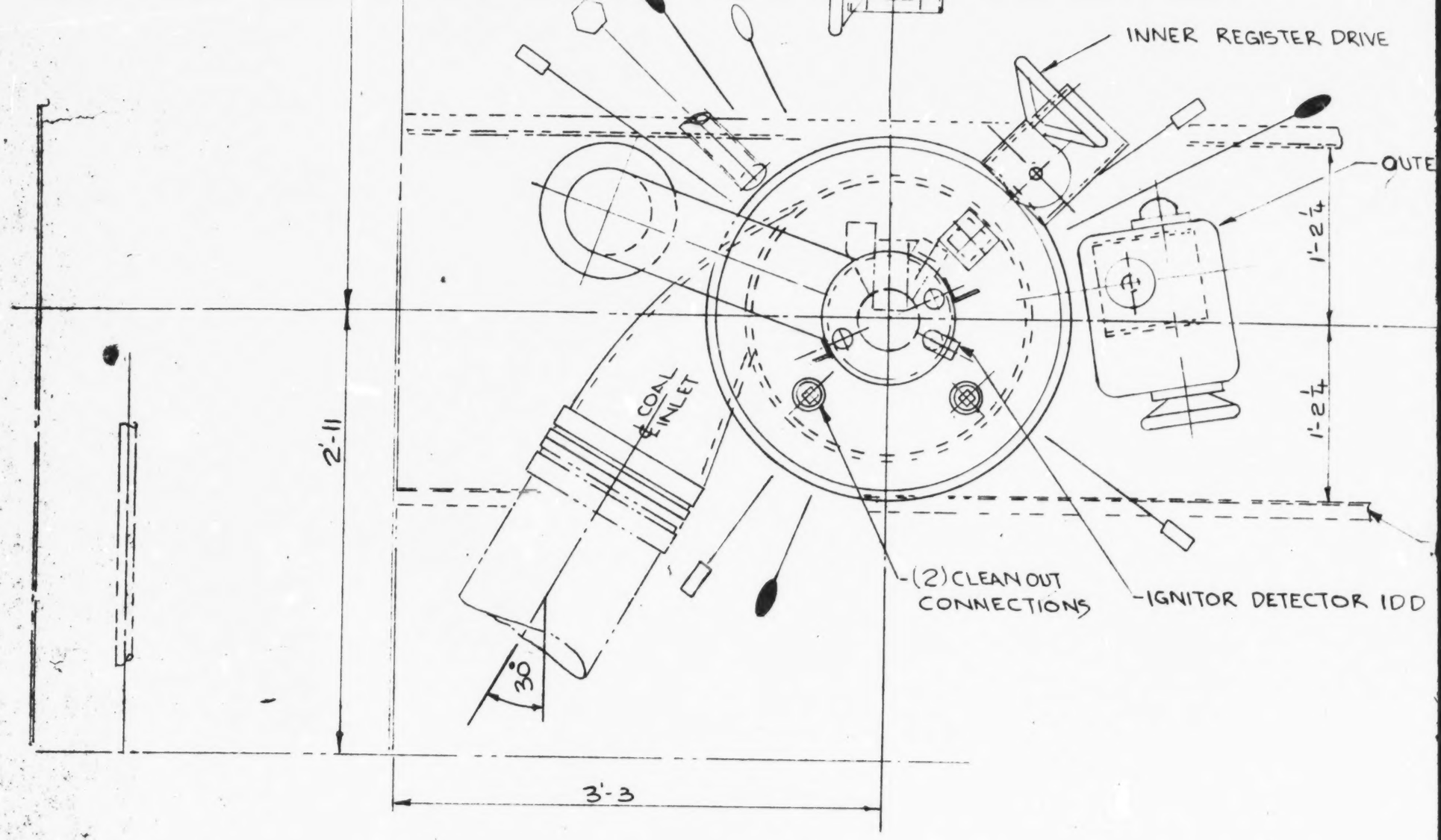
BLOWER #2

℄ EL 107.36

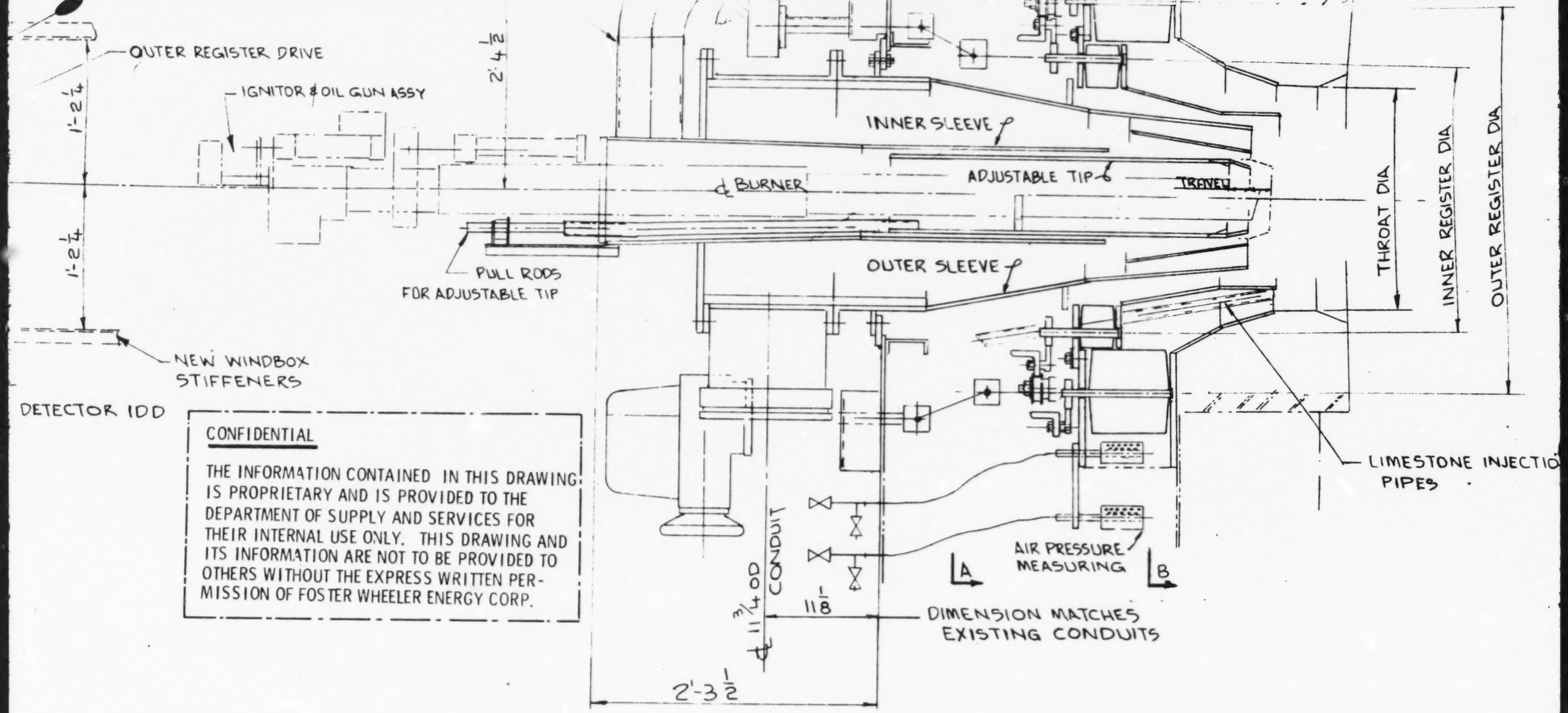
3'-6

EL 106.69

4'-0



ELEVATION AT FRONT OF BURNER

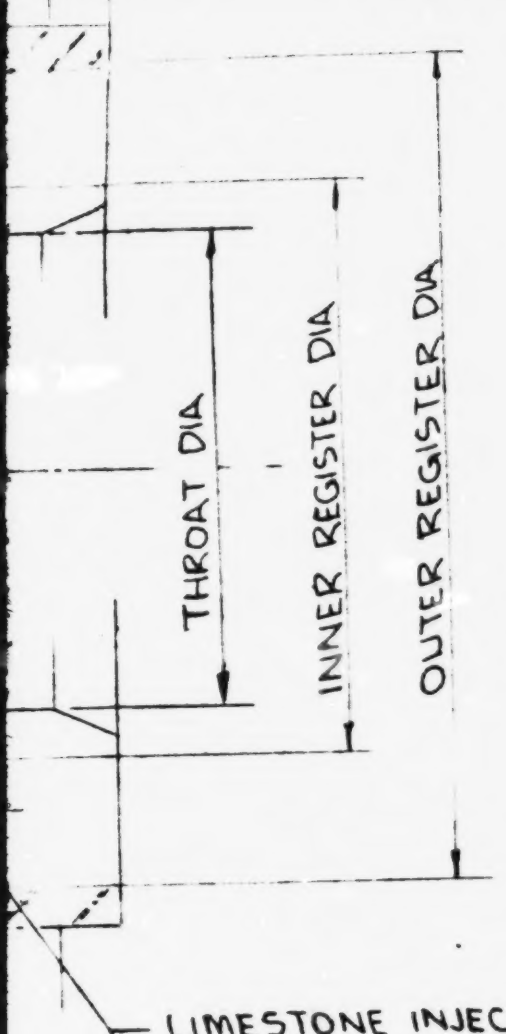


DETECTOR IDD

CONFIDENTIAL

THE INFORMATION CONTAINED IN THIS DRAWING IS PROPRIETARY AND IS PROVIDED TO THE DEPARTMENT OF SUPPLY AND SERVICES FOR THEIR INTERNAL USE ONLY. THIS DRAWING AND ITS INFORMATION ARE NOT TO BE PROVIDED TO OTHERS WITHOUT THE EXPRESS WRITTEN PERMISSION OF FOSTER WHEELER ENERGY CORP.

SECTION AT BURNER ℄
(DIAGRAMMATIC ONLY)



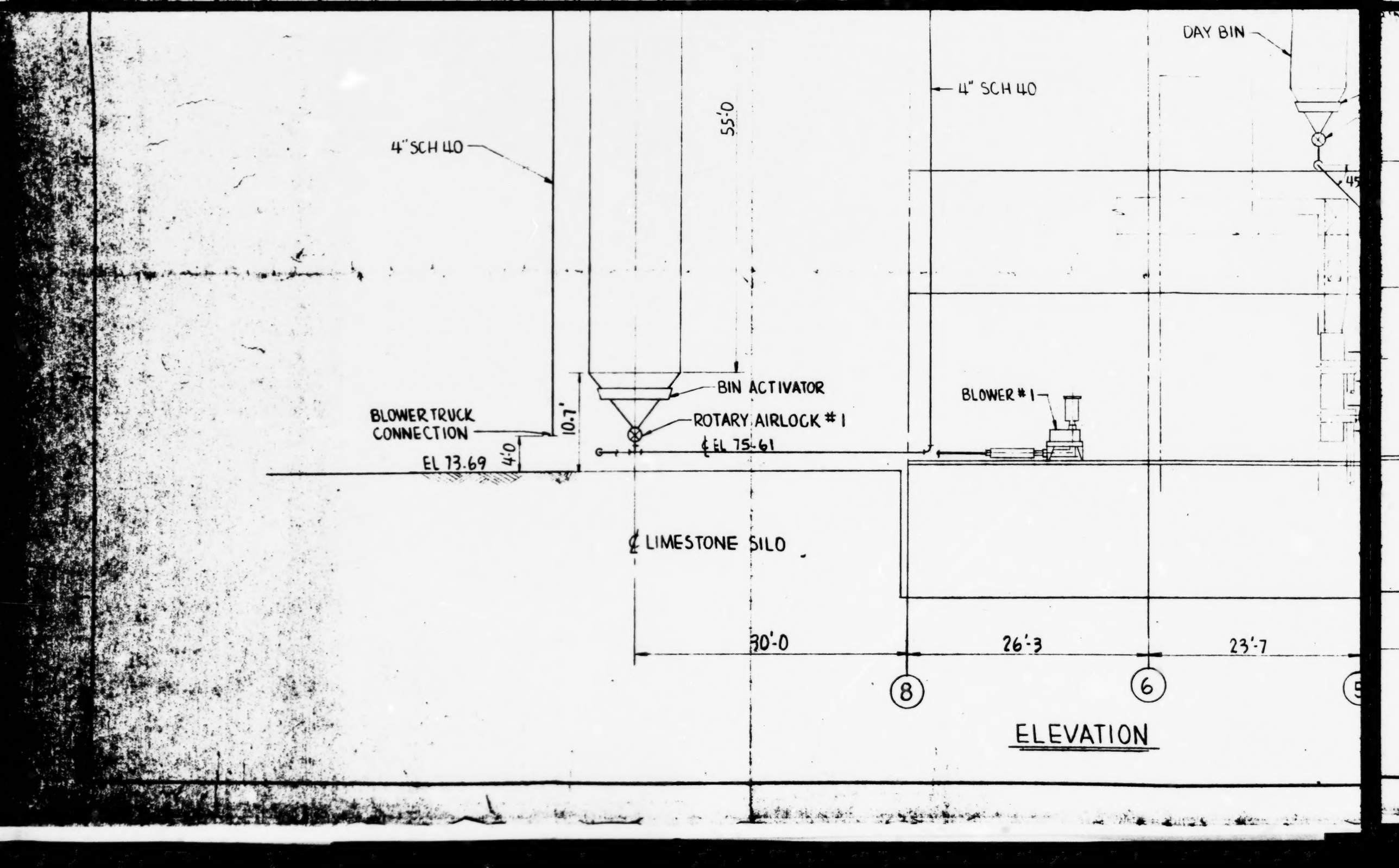
REV	DATE	BY	REVISIONS
A	2-17-83	[illegible]	[illegible]

PROPOSED ASSEMBLY OF
LOW NOx LIMESTONE
INTERVANE BURNER

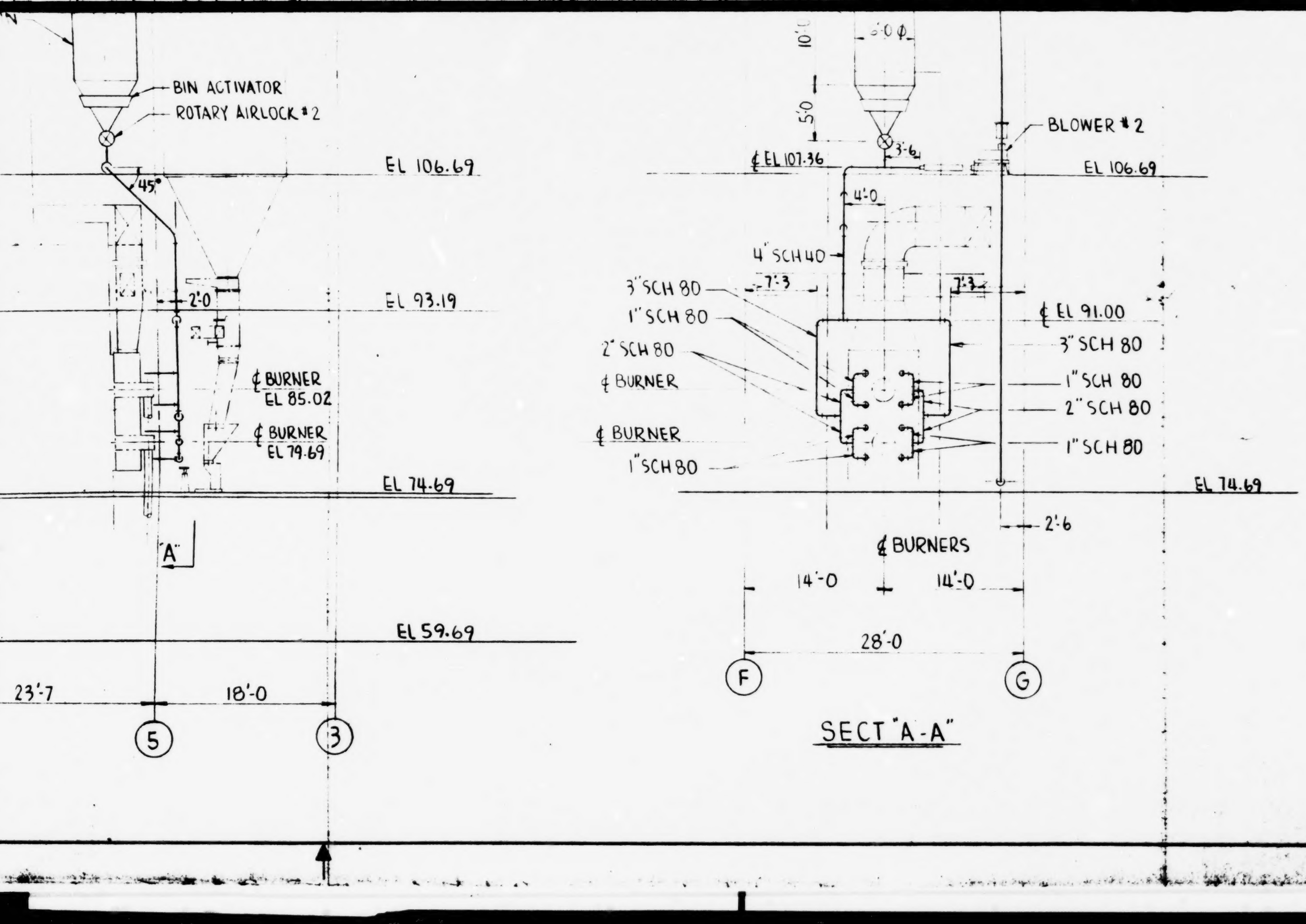
GAGETOWN CHP

DRAWING NUMBER

51-4476-5-600


4" SCH 40
55'-0
BIN ACTIVATOR
ROTARY AIRLOCK #1
℄ EL 75-61
BLOWER TRUCK CONNECTION
EL 73.69
4'-0
10.7'
DAY BIN
4" SCH 40
BLOWER #1
℄ LIMESTONE SILO
30'-0
26'-3
23'-7
8
6

ELEVATION


BIN ACTIVATOR
ROTARY AIRLOCK # 2
EL 106.69
45°
2'-0
EL 93.19
℄ BURNER
EL 85.02
℄ BURNER
EL 79.69
EL 74.69
"A"
EL 59.69
23'-7
18'-0
5
3
10'-0
5'-0
3'-6
℄ EL 107.36
BLOWER # 2
EL 106.69
4'-0
4" SCH 40
7'-3
7'-3
3" SCH 80
1" SCH 80
2" SCH 80
℄ BURNER
℄ BURNER
1" SCH 80
℄ EL 91.00
3" SCH 80
1" SCH 80
2" SCH 80
1" SCH 80
EL 74.69
2'-6
℄ BURNERS
14'-0
14'-0
28'-0
F
G
SECT "A-A"

REV	DATE	BY INIT	REVISIONS
B	1-15-83	RL	REV PER [illegible]
A	1-24-83	RL	FIRST [illegible]

PROPOSED ARRANGEMENT

LIMESTONE HANDLING [illegible]

DRAWING NUMBER

51-4476-[illegible]

POOR

QUALITY

ORIGINAL